Knowledge.

With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News.

A Monthly Record of Science.

Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

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FERMENTS AND FERMENTATION.

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(Continued from page 180).

THE cells must be able to pass something out through their envelopes, something which can alter the state of the sugar, and this something must of necessity be a ferment and a soluble one or enzyme. Thus, after all, the insoluble ferments act by means of soluble ones. A worker of the name of Büchner was the first to obtain the enzyme of yeast from the interior of the cells:—Large quantities of yeast-cells were crushed under great pressure when a liquid was obtained which, at a suitable temperature, fermented sugar to alcohol. This ferment from the interior of cells was named "zymase" and may be alluded to as an endo-enzyme. (It is now customary to make the names of ferments end in "ase.") This method of obtaining a press-juice has been extensively used to extract endo-enzymes from both vegetable and animal cells. An excellent example of an endo-enzyme of animal origin is the ferment found in the mammalian liver, which transforms the insoluble glycogen, or animal starch, deposited there into the soluble sugar which passes out of the gland into the blood to be distributed to the body. This ferment, glycogenase, is extractable from the liver even after it is dead, has been dried and kept a long time under alcohol; it is normally an intra-cellular ferment, but it can be extracted, isolated and made to do its work outside the body altogether in a glass vessel. It is itself not living, but it is the product of the living liver cells. It does not possess life, but it is possessed by life, and is the agent deputed by the living stuff to perform what would at one time have been deemed an exclusively vital function.

We might try to get some idea of the different kinds of chemical work which enzymes do; in other words classify them:—

(1) The digestive—those which dissolve respectively each of the constituents of our diet: proteins (proteolytic), starches (amylolytic), and fats (lipolytic), and many others in animals and plants.

(2) Those which dissolve cellulose (cytase) and starch (diastase), ferments active in the ripening of fruits and seeds.

(3) The coagulative— those which clot milk, blood, lymph and muscle.

(4) The oxidases, or oxygen-carrying ferments, such as the uricolytic ferment which oxidises uric acid to urea, and lactidase which oxidises lactic acid to alcohol and carbon dioxide

(5) Respiratory or tissue ferments allied to the above group; at present being investigated; probably with reducing-powers.

(6) The alcohol-producing ferments, capable of acting on many sugars.

(7) The acetic-acid-producing ferments, the cause of the souring of wine.

(8) The lactic and butyric acid producing ferment, the cause of the souring of milk.

(9) Those which oxidise ammonia in the soil to nitrites and nitrates; nitrification ferments.

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(10) Those which fix atmospheric nitrogen in the roots of certain plants; the "nitro-bacteria."

(11) The ferment which converts urea into ammonium carbonate, urease.

(12) Those producing coloured substances from colourless chromogens.

(13) Those which produce luminosity in certain lowly forms of animal life: "luciferase" acting on the "luciferin."

This list is by no means complete: it does not include the putrefactive, or the various disease-producing forms. But those mentioned are actively engaged in the everyday life of some plant or animal. In fact the whole vital field is occupied by them. The meaning of the action of most of them is sufficiently obvious; from our own personal point of view the digestive are the most important. Were it not for them our food would remain exactly as swallowed, insoluble and unabsorbable: without them we should starve though eating abundance. Many tissue-ferments only just being recognised are of immense importance. Take the case of a starving man or animal. We say in such a case the organism "lives on" its muscle and on its fat; but that explains nothing. Endo-enzymes have been discovered which dissolve the muscle and the fat of the body so that soluble substances can get into the blood and thus be carried to the heart and nervous system for their nourishment. Hence after a period of starvation or hibernation, the animal is found to be exceedingly thin; its tissues have literally been dissolved away.

The rôle of the putrefying and nitrifying ferments is of the highest importance in the maintenance of animal life, and in the continuous circulation of nitrogen which goes on. As soon as an animal is dead, millions of bacteria set about dissolving its tissues into a large number of different chemical substances such as amides, amino-acids, ammonia, compounds of sulphur, marsh gas, and certain highly poisonous substances to which such names as "cadaverine," "putrescine," have been given. Some of these are gaseous and escape into the atmosphere; those containing nitrogen are attacked by the nitrifying micro-organisms and converted into salts which are utilised as the food of plants. The plants form vegetable proteins which are eaten by herbivora; man and the carnivora eat the herbivora—so that "all flesh *is* grass." "Imperial Cæsar dead and turned to clay" does not remain "clay." His imperial nitrogen undergoes many vicissitudes, and may conceivably, in course of time, even become part of the body of a descendant.

The respiratory ferments believed to reside in the depths of the tissues are exciting a good deal of attention at the present time. It is now coming to be believed that the tissues actually obtain their oxygen from the blood by aid of a reducing-ferment or "reductase" which hands over the oxygen to an oxidase which applies it to the oxidation of the carbon and hydrogen of materials in the cells, with the consequent liberation of heat.

A particularly interesting ferment has lately been recognised in certain coloured flowers; the beautiful colour of a purple or pink sweet-pea is due to the interaction of a chromogen with an enzyme. If either one or the other is absent the flower is white; the chromogen alone gives a white petal, so does the enzyme alone.

We might now look into the various characters possessed more or less completely by all ferments.

The first characteristic common to them all is that they cannot work in the absence of water. Expressed chemically this is, that they act by hydrolysis. The fungi and the bacteria, as well as the enzymes, are quite inert when dried up. Yeast in a dry state will not ferment dry sugar; boots must be damp to have the growth of green mould on them; it is because jam is moist that fungus grows on it; no perfectly dry thing will decompose. It was because it was sun-dried that Livingstone's body was able to be preserved in Central Africa and brought to England for burial.

The second characteristic is the excessively minute quantity of the enzyme which is able to transform an enormous quantity of material acted on (substrate). Thus one part of rennin, the milk-clotting ferment, can clot four hundred thousand parts of milk: one part of pepsine in seven hours can digest five hundred thousand parts of fibrine.

The third point is that the ferments, like true catalysts, do not incorporate themselves with the products of their activity: pepsine is recoverable after it has peptonised.

The fourth feature of ferments is their affectability towards changes of temperature. A ferment of whatever kind can be active only within a certain range of temperature, and within that range there is a particular temperature at which the ferment works most rapidly; this is called its "optimum temperature." On each side of the optimum the ferment works less and less energetically or perfectly. As the temperature rises the ferment is inhibited, and at last a temperature is reached at which it ceases to work altogether. This is the destruction or "death" temperature, the ferment will not work again under any conditions. As one lowers the temperature from the optimum, the ferment is similarly progressively inhibited until it ceases to work altogether, but can work again when the temperature is raised. But no low temperature has been reached which destroys ferments in the sense that a sufficiently high temperature does. Professor MacKendrick kept organisms of putrefaction for a hundred hours at minus 83°C.—a temperature sufficient to freeze alcohol—without killing them. Putrefaction was arrested, but, on the temperature being raised, became as active as ever. Similarly, the late Professor Macfadyen found that the temperature of liquid air (minus 250°C) would not kill certain

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disease-producing bacteria: the present writer has found that twenty-four hours' exposure of liver and kidney press-juice to as low a temperature as minus 11°C does not in the least impair the subsequent capability of chemical reduction possessed by a tissue-ferment provisionally known as "tissue-reductase."

The fifth characteristic of ferment action is the tendency of the ferments to be inhibited by the accumulation of the products of their own activity. Thus alcohol rising to 14% puts an end to the alcoholic fermentation in wine-making, the presence of peptones restrains pepsine, and similarly in other cases. The toxines of disease germs inhibit the activity of the micro-organism; when this happens in a living person, the person recovers. Of course within the body an accumulation inhibitory to the digestive enzymes does not occur, owing to the constant absorption normally going on in the digestive processes.

An exceedingly interesting chapter in fermentation is that dealing with the activators or the kinases as they are called. Not all enzymes exist at all times in an active state: certain enzymes are secreted in an inactive state, and may remain inert until some substance—which is not always a ferment—has reached them to activate them. These activators may be dilute acids, sometimes they are other ferments (kinases). Thus pepsine does not exist in the active state in the cells of the gastric glands, but in an inactive (zymogen) condition; this antecedent state being known as pepsinogen. As soon, however, as the hydrochloric acid of the gastric juice gains access to the pepsinogen, it converts it rapidly into the active pepsine. Thus the old puzzle, "why does the stomach not digest itself," is solved. The answer is, the gastric glands do not contain the active form of the ferment, but only the inactive, or zymogen. A very interesting case of ferment activation has been discovered within the last few years. Freshly secreted pancreatic juice does not of itself digest albumins, neither does pure intestinal juice—the *succus entericus*—but if a very little succus be added to the pancreatic juice, a most powerful digestive action is developed, trypsinogen has been activated. Now, since the addition of boiled succus entirely fails to activate pancreatic juice, we seem justified in believing in the existence of an enzyme in the intestinal juice whose office it is to activate the pancreatic; this kinase is called entero-kinase.

Enzymes are not only exceedingly sensitive to variations of temperature, but also to the chemical reaction of the medium in which they find themselves. Thus ptyaline of the saliva can convert starch to sugar only in a slightly alkaline or neutral medium, pepsine can act only in an acid medium and really well only in presence of hydrochloric acid from 0·2% to 0·4%, while the pancreatic enzymes all need frankly alkaline surroundings. Departures from the normal acidity in the stomach constitute certain forms of dyspepsia.

Again, certain ferments only act properly in presence of lime salts. Such are rennin, the milk-clotting, and thrombase, the blood-clotting enzyme. The discovery of anti-ferments is one of the most curious in this interesting subject. It explains another old puzzle which was, "Why are the parasitic intestinal worms not digested by the intestinal juices of their hosts"? The answer is that the worms have actually acquired the power of producing a ferment which antagonises the trypsine of the pancreatic juice; that is, an anti-trypsine which effectually prevents the tryptic enzyme exerting its solvent action on them. This is a remarkable example of adaptation to environment.

The last characteristic of ferments which may be noticed is their specificity, individuality, or mutual non-interchangeableness. Thus pepsine can act on proteins, and on these alone; it is quite powerless to digest starch or pure fat. Similarly the starch-dissolving enzymes are absolutely inert as regards proteins or fats.

But more than this as indicating a high specificity, only those sugars containing six or nine atoms of carbon are capable of alcoholic fermentation. The yeasts are perfectly non-affectable towards sugars containing seven or eight atoms of carbon. These latter sugars do not occur in Nature—they have only lately been synthetised by the chemist—so that the yeasts and their ancestors have had no experience of them. The yeasts know nothing of them; they are unable to come into chemical relationship with them. But by "education" the yeasts can be forced to become familiar with them, to attack them—"which things are an allegory." This curious specificity has been explained or rather illustrated by the analogy of a lock-and-key. As there is only one key which fits one Yale lock, so there is only one enzyme which will break down or dissolve one particular kind of substance. The molecular configuration of the pepsine key will not fit into the molecular structure of the starch or sugar lock.

In a certain sense, the discovery of ferments, or at least the acceptance of the doctrine of enzyme-action, has revolutionised biology. It is hardly too much to say that life is synonymous with the power to produce ferments. From the amœba in the stagnant horse-pond up to the "noblest work of God," enzymes are essential to the exhibitions of vitality: the ferments are omnipresent, and, in their own sphere, omnipotent.

It is curious, but true, that such exceedingly different phenomena as the digesting of one's dinner, the making of cheese, the manufacture of wine, the disappearance of the dead, the colour of the delicate corolla of the flower on the sun-lit hills and the "uneffectual fire" of the gleam of the glow-worm in the silence of the night, are alike due to these hidden, mysterious, but none the less real, agents of living matter, the soluble ferments.

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QUESTIONED DOCUMENTS.

By C. AINSWORTH MITCHELL, B.A. (Oxon), F.I.C.

AMERICA has added to the English language many words and phases, some of which are particularly happy, while others may be euphemistically described as devoid of beauty.

Among the more picturesque expressions of American origin must be included the term "Questioned Documents," which is a useful description of all letters and papers the authenticity of which there is reason to doubt; and the occupation of "Examiner of Questioned Documents" is now a recognised profession in the United States.

Most of the investigations of this nature in America have dealt chiefly with the character of the handwriting, and it is only recently that any degree of attention has been given to the scientific examination of the ink, paper, and so on.

There is, however, one form of fraud which appears to have been more common in America than in this country, and to the detection of which the most scientific methods of examination have been applied. This is the imitation of a signature by means of tracing.

Such an imitation is not always easy to detect, and it requires a careful microscopical examination of the writing to show the irregularities in the flowing of the ink and the want of decision in the strokes which invariably accompany a careful tracing. In some notorious cases the model from which the forger traced his copy has been discovered, and the extremely close correspondence between the two signatures has shown that one of them must have been traced.

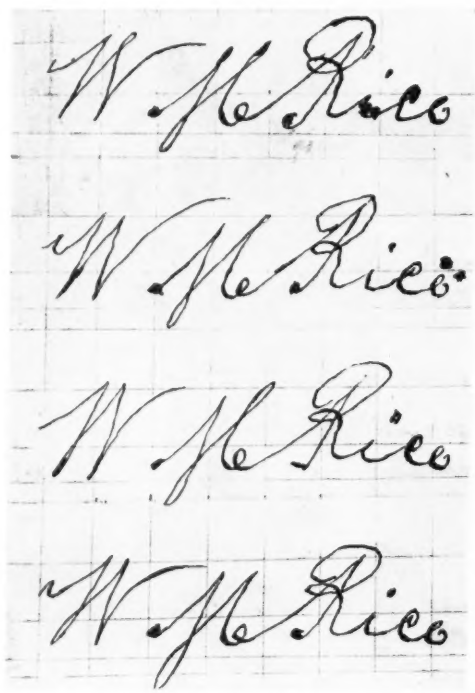

FIGURE 230.

The four disputed Signatures on the Will in the Rice-Patrick Case.
Photographed under glass with ruled lines.

An American counsel, in the course of his speech in a trial of this kind, remarked:—"It has been said that if a person meet in a waste place three trees growing in a row, he thinks they were so planted by man; should he find the distances equal he is convinced. Such accidental situation of thirty trees would not exceed in strangeness a coincidence like the one in this case."

In this trial, known as the "Sylvia Ann Howland case," in which evidence was given as to the coincidence of all the letters in the disputed and genuine signatures, Professor Pierce, of Harvard, stated in the witness-box that the probability of all the thirty downward strokes in the two writings coinciding would be one chance in nine hundred and thirty-one quintillions.

I am indebted to the kindness of Mr. A. S. Osborn, of New York, for the details and illustrations of a celebrated trial, in which he gave evidence as to the practical certainty of disputed signatures being tracings.

About ten years ago a man named Rice died in New York at the age of eighty under somewhat suspicious circumstances, leaving an estate worth about five millions of dollars. The day after his death cheques for several hundred thousand dollars, signed with his name, were presented by an attorney named Albert T. Patrick. These cheques being regarded as suspicious, Patrick was arrested and put on trial for the murder of the old man. The jury found him guilty, and he was sentenced to death, though the sentence was afterwards commuted to imprisonment for life.

After presenting the cheques Patrick had produced a will, according to which the remainder of the estate was made over to him; and his claim was tried in the civil courts, simultaneously with the criminal trial.

This alleged will consisted of four pages, and upon each of these was the signature, "W. M. Rice." All four signatures showed a close correspondence in form, while on the other hand five genuine signatures of Rice, written on the day the will was supposed to have been signed, showed pronounced variations in size, form, and shading, and when photographed under glass with ruled squares did not exhibit the same relative positions for the different parts of the letters. (See Figure 230.) The Court, having had these facts demonstrated to them, pronounced the will a forgery, and the same judgment was unanimously given in two Courts of Appeal to which the case was carried. In the final judgment it was

stated that, "Upon a critical examination of the four signatures it will be found that they correspond almost exactly—a correspondence which could not possibly happen in the case of a person upwards of eighty years of age."

FIGURE 231.
Early Watermark in Paper.

With regard to this and similar cases it may be remarked that it is not always possible to demonstrate so thoroughly the tracing of a signature, and where there is only one signature involved and the model cannot be found proof must, at best, lack completeness.

Coming now to the question of the nature of the paper of a suspicious document, there are numerous starting places for an examination. Obviously, the watermark will be carefully examined and compared with that in the paper in other documents in the case. An anachronism of the watermark has before now proved that certain writings could not possibly be as old as they were claimed to be.

For instance, forged historical autographs have been detected through having been written upon paper with a watermark of a later period than the alleged date of the writing. The early devices used as watermarks were very characteristic, as may be seen in the accompanying interesting examples, which Dr. Scott has kindly allowed me to reproduce from his book "Historical Documents" (see Figures 231 to 234.)

Evidence of this nature was given at a trial some years ago and it was proved that a letter, alleged to have been sent from Venice, had been written upon paper made in England at a later date.

FIGURE 233.
Early Watermark in Paper.

The evidence of the watermark, however, is not always conclusive as to the date of the paper, since manufacturers may intentionally use moulds of a wrong date. Thus, in a trial which took place in 1834, in Edinburgh, evidence was given by the paper manufacturers that they were post-dating their paper, and were using moulds with watermarks of 1828 pattern to supply a special order. It is only a clumsy forger who will lose sight of the silent testimony of a watermark, but he cannot so easily protect himself against variations in the structure and composition of the paper itself.

In the old type of paper made from rags little difference can be observed in the structure of different samples, each showing more or less disintegrated fibres of cotton or linen, such as are seen in Figure 235, which represents the microscopical appearance of a fragment of eighteenth-century writing-paper.

FIGURE 232.
Early Watermark in Paper.

At the present day paper is made from wood pulp, and all kinds of vegetable fibres, and it is only the more expensive qualities which are still made exclusively from rags.

A specimen of a so-called Manilla writing-paper gave the microscopical appearance shown in Figure 236. For these two drawings I have to thank my friend, Mr. R. M. Prideaux. It is obvious that the production of a piece of writing dated, say, thirty years ago, would probably not be genuine if written on paper with the structure of the second specimen.

But apart from the structure, there are pronounced differences in the amounts of ash and in the nature and quantities of the numeral constituents in the ash of modern samples of paper.

For instance, Levi (*Zeit. angew. Chem.*, 1910, XXIII, 1258) has devised a sensitive method of estimating the amount of sulphur in paper by means of the yellow colour produced on adding alkaline lead acetate to the fused ash. So sensitive is this test that a perceptible yellow coloration was given by an ash containing as little as 0·00000303 gramme of sulphur.

Further valuable tests of the genuineness of a document may be based upon an examination of the sizing.

It has not infrequently happened that a slight erasure has changed the whole sense of a letter.

An instance of this came within the writer's experience, where a letter containing the words "our house" was put forward as evidence as to the ownership of the property.

FIGURE 234.
Early Watermark in Paper.

When this was examined under the microscope by transmitted light it showed unmistakeable signs of erasure in front of the "our," the sizing having been removed and the fibres scratched up apparently with the point of a knife. The paper was also more transparent at the place where the erasure had taken place.

These facts supported the contention of the other side that the original reading had been "your," and that the "y" had been erased.

To lessen the chance of detection from such a trail, skilful forgers have been known to paint the place over with a resinous solution, so that superficially it has the appearance of the rest of the surface of the paper. This dodge may be detected by an examination of the sizing, the patched place being easily stripped by brushing it over with alcohol, in which the resin will dissolve.

Tests have also been devised for distinguishing between papers sized with material of animal and of vegetable origin. For instance, if a small piece of the paper be soaked in a two per cent. solution of copper sulphate, and then treated with a few drops of a five per cent. solution of potassium hydroxide, a violet coloration (the biuret reaction) is at once obtained if gelatin or casein is present.

In certain cases "Hughes' iodine reaction" may also aid in the differentiation of two kinds of paper. If a strip of paper is moistened with potassium iodide solution and suspended in a place protected from chemical fumes, a gradual liberation of iodine will take place. This appears to be due to the presence of undecomposed alum or aluminium sulphate in the paper, and according to Strachan (*Chem. News*, 1911, CIII, 193), the intensity of the coloration affords a measure of the latent acidity (due to the alum) in the paper. It also gives a probable explanation of the rapid deterioration of certain modern written documents.

Commercial papers differ considerably in their behaviour in this test, and upon its results may be based an approximate estimation of the amount of undecomposed alum present.

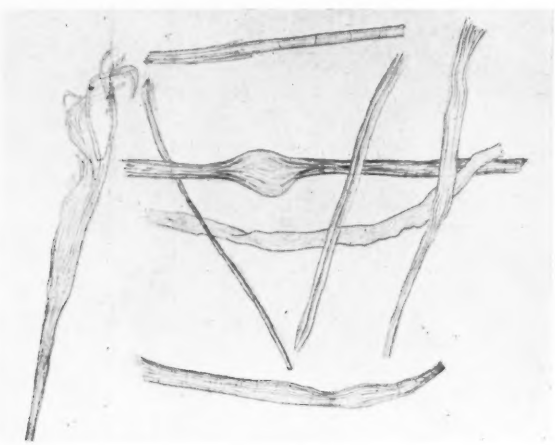

FIGURE 235.
Fibres from Eighteenth Century Paper.

In addition to the ink, the paper, and the writing itself, there are frequently other points about a questioned document which will repay careful examination; for the pitfalls are so numerous that in avoiding one a forger will almost certainly fall into another.

In illustration of this the following amusing case within the writer's experience may be cited:—A Jewish family insured their household goods and, in particular, a quantity of valuable jewellery, with one of the leading insurance companies in London. Being thus protected, they soon became the prey of enterprising burglars, and in this unfortunate affair lost all their jewellery, which was valued at about £150.

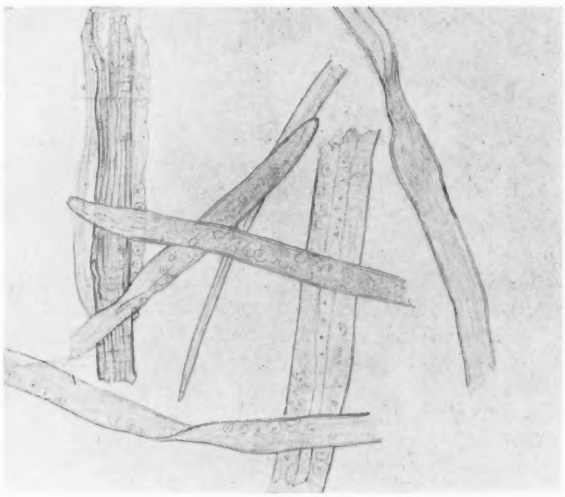

FIGURE 236.
Fibres from Modern "Manilla" Writing Paper.

In the claim presented to the company receipts were produced signed by the jeweller from whom, as they alleged, they had bought the jewellery.

Such claims, when not genuine, are not easy to disprove, although in the present case the insurance company had a strong suspicion that there had been no burglary, but that bogus receipts had been concocted in collusion with the jeweller, who had an address but no shop.

There were in all three receipts, the first made out in December to the eldest daughter, the second in January to the father, and the third, which was dated in February, to the daughter, who had been married since the date on the first receipt.

The paper of the bill-heads of the first and third receipts was of the same kind, and the writing on these was in the same sort of ink, whereas the paper and ink of the second receipt were of a different kind.

The inks upon the first and third bills were of too recent origin to determine whether they were of the same age, although it was significant that they behaved in exactly the same way towards bleaching reagents.

Much more conclusive, however, was the fact that the right hand side of the receipt stamp upon the earlier bill corresponded in every detail with the left hand side of the stamp upon the later bill. Wherever, in tearing the stamps apart, a short projection had been left on the one there was a corresponding long projection upon the other. In fact, throughout the whole of the seventeen projections there was perfect coincidence in every point, as is shown in Figure 237. This agreement could scarcely have been accidental, the chances against such complete correspondence being overwhelming, while it was most improbable that the jeweller should have kept one of two adjacent stamps for three months and have then affixed it to a second receipt given to the same person.

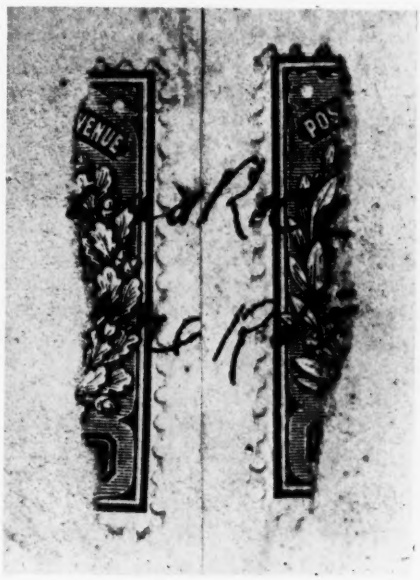

FIGURE 237.
Coinciding edges of Receipt Stamps.

The only alternative to these conclusions was that the stamps had been put at the same time upon receipted bills dated three months apart. This view appeared convincing to the insurance company, and they refused to meet the claim.

It is perhaps in tracing the authorship of anonymous letters that the circumstantial evidence of overlooked trifles may prove the most valuable.

Of late, such letters have frequently been typewritten, evidently under the mistaken notion that in this way the identity of the writer would be effectually concealed. But, unfortunately for the anonymous letter-writer, each typewriter has its own idiosyncracies, and the differences that may be noted between the letters upon two new machines become much more pronounced with use.

The types become worn and soon get out of alignment, and as the faults of spacing and position repeat themselves or become more accentuated it is not a difficult matter to prove that a letter must have been written upon a particular machine.

Observations made by the writer have shown that letters written upon the same typewriter at intervals of over a year will exhibit corresponding peculiarities.

This is seen in Figure 238, which shows enlarged photographs of typewritten words. These words were part of an anonymous letter received by a clerk, accusing him of having taken a sum of money, and threatening him with exposure if he did not "return the amount."

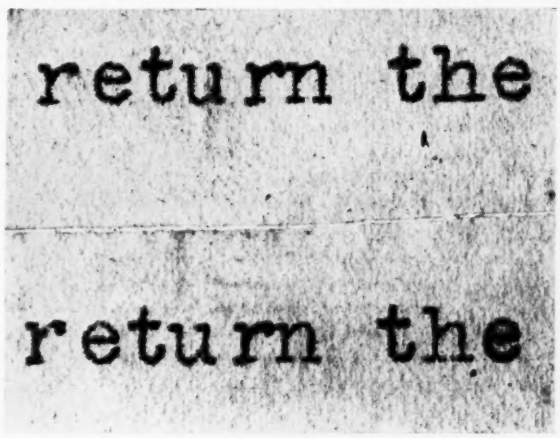

FIGURE 238.
Typewriting done on the same Machine.

Suspicion pointed to a certain individual as the sender of the letter, and the suspicion was proved to be well founded by the results obtained on typing the words upon his machine.

On first thoughts it would hardly seem likely that the sealing wax in the seals upon a letter should afford any useful information, but the Fink case proves that the composition of the wax may furnish a strong link in a chain of evidence.

In October of last year, Major Fink was tried at the Old Bailey on the charge of having forged a cheque by altering the amount from £10 to £10,000.

The alteration had been clumsily done, and it was obvious even upon casual inspection that there had been tampering with the words and figures.

The ink in which these alterations had been made was of the same kind as that of Major Fink's endorsement upon the back of the cheque, and as that contained in his fountain pen, while it was of a different kind from the ink in the signatures on the face of the cheque.

The prisoner asserted that the amount of the cheque was only for £10 when he had posted it, and his suggestion was that the letter had been tampered with while in the post.

Now it had been sent to the bank in a registered sealed envelope, and had been followed by a second letter also in a sealed and registered envelope. A

stick of red sealing wax was found in the possession of Major Fink and the question therefore arose whether this wax agreed in composition with the wax in the seals upon the two letters.

The close agreement in the composition of the stick of sealing wax and the seals upon the two letters left little room for doubting the origin of the latter.

Sealing Waxes.	Ash. Per cent.	Ash Insolvent in Acid. Per cent.	Sulphate in Ash. Per cent.	Resins. Per cent.	Vermillion. Per cent.
Major Fink's Wax	38·20	16·56	13·14	46·71	32·59
Seals on Letter I.	38·29	16·43	13·44	46·77	32·25
„ „ II.	38·26	16·58	13·58	46·57	—
Commercial Wax I.	57·37	37·67	20·79	—	present
„ „ II.	28·66	23·92	3·27	—	„
„ „ III.	73·82	73·08	nil.	—	„
Seal on Parcel	19·64	Trace	—	—	„
„ „ Letter	40·40	12·59	10·25	—	„
Wax from Post Office	50·11	Consisting chiefly of iron oxide. No vermillion.			

TABLE 19. Composition of Sealing Waxes.

At the same time an analysis was made of the wax from the post office where the letters had been posted, and of various other commercial specimens of sealing wax, taken at random, and the results which were obtained are given in Table 19.

After hearing evidence upon this and the other scientific points raised in the case, the jury found the prisoner guilty, but they also concluded from the medical evidence put before them that he was insane at the time he committed the forgery.

THE OLDEST HERBARIUM IN THE WORLD.

By ELEONORA ARMITAGE.

WHEN I found my way to the secluded gallery in the great Museum of Antiquities at Kasr el Nil, in Cairo, where repose what are, I suppose, the most ancient dried plants on the face of the earth, I wondered how many people ever paid them the tribute of a passing inspection! Men come in thousands to wonder at and admire the vast assemblage of human handiwork of byegone ages, gathered from a thousand miles of the Nile Valley, but there seemed to be scarcely one who cared to enter and ponder for a few moments on these works of nature, preserved by the men of Ancient Egypt with care and loving reverence to do honour to the dead, whose earthly tabernacles were to last like these for scores of centuries.

One's memory is recalled to that era of brilliant civilisation and of elaborate development of art which obtained during the Eighteenth and Nineteenth Dynasties, a period between the seventeenth and twelfth centuries before Christ, which is especially associated with the names of Amenhotep, Thothmes, and Queen Hatshepset, and later with those of Seti the First and Rameses the Second, the Great.

For what are we gazing at? Garlands and wreaths from the tombs of these kings. There is no question here of the ancient floras of the earth, which are hewn from time to time from the rocks to rejoice the heart of the palaeo-botanist; these plants are all truly "recent" in the geological sense; but the fact that they are all precisely similar in every detail with their congeners growing in the Nile Valley to this day, proves the antiquity and persistence of certain species of plants. It is interesting to see the ancient and modern specimens mounted side by side in the cases to invite comparison.

The long wreaths taken from the mummy cases of Aahmes I and Amenhotep I were elaborately and beautifully made. To a strong foundation of palm-leaf fibre were tied a close succession of split and folded leaves of the Mimusops Tree, large oval leaves, tied with narrow thongs of palm fibre, while within each leaf was placed a petal of the Blue Water Lily, the Lotus of the Nile. It is astonishing to see how well these petals, now brown or white, are preserved. Other wreaths had a foundation of Willow leaves between which were the fragile petals of a Hollyhock, or blue Larkspur flowers were used, while sometimes in addition we find the sweet-scented yellow balls of the Nile Acacia, the Sunt. Some of the wreaths investing the mummy of Rameses II when it was found at Der el Bahari had been renewed by the pious care of some Twentieth Dynasty ruler, and were composed of Mimusops and of another species of Lotus. There were floral neck-wreaths, too: one made of wild celery leaves all smoothly pressed out, another of malt, the germinated barley with a thick tangle of rootlets; besides which are found branches of Olive, of the Sycamore Fig, and leaves of the creeping desert Gourd, the Colocynth, and several other flowers. Numbers of seeds of this period have been found, chiefly of cereals, legumes or forage plants, just the same kinds which are still grown by the industrious fellahin on the irrigated land.

Before we leave the gallery we must glance at the portraits in colour of several of the native Nile plants which we see on the walls. These come from the palace of the well-known heretical king, Akhenaten, of the Eighteenth Dynasty, who, deserting the ancient worship of the Sun God for that of the Solar Disk, left Thebes to build a new capital at Tel el Amarna. Needless to say his successor returned to the old faith and the old city; but here we see how the floors of reception halls in royal palaces four thousand years ago were decorated. The stucco pavements were painted over with designs of water with aquatic birds and beasts amid clumps of vegetation, reeds and grasses, the colouring being green, red and blue on a white ground. Here one recognises red and blue Lotus flowers, there waving Reeds and Papyrus, blue-headed Thistles, Scarlet Poppies and trails of Convolvulus, all depicted with exact yet conventional accuracy.

Who is there that has voyaged to the upper Nile and has not seen the water, and the stretches of vegetation and the birds and the beasts, and may not yet see the Chieftainess of Thebes, the Sacred Cow of Hathor, pushing her way through the Papyrus brakes and Nile Lotus, even as she is depicted on her statue which came from Der el Bahari? Egypt is very old—and yet she *is*.

SOME PRIMITIVE BRITISH INSECTS.

I.—THE PROTURA.

By RICHARD S. BAGNALL, F.L.S., F.E.S.

AN insect without antennae!

It was on the occasion of a field meeting of the Northumberland, Durham and Newcastle-upon-Tyne Natural History Society, at Mitford, Northumberland, in the May of 1909, I first met with this curious form of insect life. I remember I was searching for those tiny, bustling centipedes, the Pauropods, at the time. Under a log lying by the roadside was a colony of *Pauropus*—of a species then unrecorded as British—and with it were two small creatures, yellowish and to all appearances larval. But under a lens they presented an altogether strange appearance, chiefly on account of their conical beak-shaped heads, and of the great development of the fore-legs, the peculiar posture thereof reminding one of the Praying Mantis. I therefore bottled them, and placing them under the microscope at home I discovered other peculiarities no less striking.

From photographs *by G. Lishman, D.Sc.*

FIGURE 239.

FIGURE 240.

Acerentomon affinis Bagn., enlarged. The natural size is 1·6 mm.

The mouth parts were quite unlike those of any other insect known to me; eyes, antennae and wings were absent; the claws were similar to those of the bristle-tails (Thysanura), the last abdominal segments reminded one curiously of a crustacean, and there were no spiracles. Several structural features, including the genitalia, proved that the insect was not larval.

I felt that I had thus stumbled upon an entirely new type of insect, and as such labelled my preparation, but lack of knowledge and literature together with the pressure of other interests and important work, forced me to put it to one side.

It is curious how strange occurrences such as this revolve in one's mind. Without antennae, eyes and wings! We can bring to mind whole orders of wingless insects, such as the springtails (Collembola), bristle-tails (Thysanura), bloodsucking and biting lice (Anoplura and Mallophaga) and numerous sightless arthropods. But without antennae, or in other words, without either of the organs of sense, the eyes and antennae! This curious creature was brought before me more forcibly by the discovery of a second species in 1910, a third in August and yet another in December, 1911, the latter in profusion, and whilst recently corresponding with Professor Filipo Silvestri on other matters, I sent him a rough sketch and asked his opinion. He informed me that these insects were, as I had thought, true insects, and that they belonged to the order Protura, an order diagnosed by him as recently as December, 1907.

Thus ended my dream of the first discovery of an entirely new type of insect!

Its history is, however, a short one; the insect is known to very few naturalists, and yet about a dozen species have been described, mostly by Berlese from Italy, who, in 1909, monographed the order in his usual most thorough and comprehensive manner.

FIGURE 241.

The anterior end of *Acerentomon*, greatly enlarged.

Acerentomon—"An insect without antennae," that is the literal translation of the name proposed by Silvestri. ἀ=without; κέρας=antenna; ἔντομου=insect. Could a more appropriate name be chosen?

The position of the front pair of legs suggested to me that they, in a measure, protected the head. I recently had the opportunity of watching the living insects, and it was especially interesting to note that the long front legs were not used to any extent for walking, but as feelers held tremulously on each side of the head, and this observation is confirmed on examination of the fore-tibia under a high power, when sense-organs similar to those found on the

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antennae of many insects can be clearly seen.

The known species fall into two families, the representatives of one family, Acerentomidae (containing most of the species), are without stigmata; those of the second family, Eosentomidae, possess a complete tracheal system and two pairs of stigmata on the meso- and metathorax respectively. All species possess three pairs of abdominal appendages, one on each of the first three segments of the abdomen, but in the Acerentomidae the second and third pairs are vestigial, whilst in the other family they are all similarly well-developed and distinctly two-jointed. These are the abdominal feet—*pedes abdominales*—of Berlese.

The first family is composed of two genera, *Acerentomon* and *Acerentulus*, the former being characterized by the beak-like prolongation of the upper labrum; the second family contains but a single genus, *Eosentomon*. Both families (and the three genera) are represented in my English material, but with the exception of a species of *Acerentomon*, which I propose to name *Acerentomon affinis* on account of its close relationship to *Acerentomon doderoi* Silvestri,* the type of the order, and which occurs under the bark of an old elm log in Gibside in considerable profusion and in the Wear Valley, my material is not well-preserved. A minute new species of *Eosentomon* occurs very sparingly in a quarry near my home at Penshaw, County Durham, together with a recently-described Pauropod (*Brachypauropus lubbocki* Bagnall).

Anyone familiar with the haunts of *Pauropus* will in all probability become acquainted with the *Protura*, perhaps the most primitive and bizarre of insects.

* My examples have been examined by Silvestri, who considers that they are not referable to his *A. doderoi*.

SOLAR DISTURBANCES DURING APRIL, 1912.

By FRANK C. DENNETT.

DURING April only nine days—7th, 19th, 20th, and 22nd to 27th—are registered as without solar disturbance. On twelve others only faculae were observed. The longitude of the central meridian at noon on the 1st was 38° 11′.

On the 2nd a pale faculic knot was seen at longitude 86°, S. latitude 22°, and another near longitude 326° in high southern latitude. Close to the eastern limb, latitude 11° to 13° South, a bright disturbance showed, which was better seen on the 3rd and 4th when it contained a bright horseshoe-shaped form. It was double, one from 287° to 293° and extending to 316°. These were not so well seen on the 5th and 6th, when farther advanced upon the disc. On the latter date two other faculae were visible around longitude 261°, S. latitude 10°, and 48°, 19° S. On the 9th a knot was seen in S. latitude near longitude 5°. On the 12th there was a pale faculic area around longitude 183°, in 7° S. latitude. On the 14th a pale facula was situated around longitude 297°, in 50° N. latitude. On the 15th the faculae behind the spot group were visible within the western limb. There appeared to be faculic disturbance around longitude 202° in N. latitude 50° on the 16th. On the 17th, several small flecks of brightness were noted scattered about the disc, but none were measured. On the 18th, a pale faculic disturbance was situated near the equator about longitude 108°. On the 21st there was a pale facula near longitude 54°, N. latitude 3°. On the 28th, 29th and 30th the faculic disturbance from 295° to 324°, in S. latitude 4° to 17° was within the eastern limb.

No. 2.—A small pore about two days past the central meridian on April 1st, and about which minute companions showed at times. Its position, only seen on one day, is kindly communicated by the Astronomer-Royal.

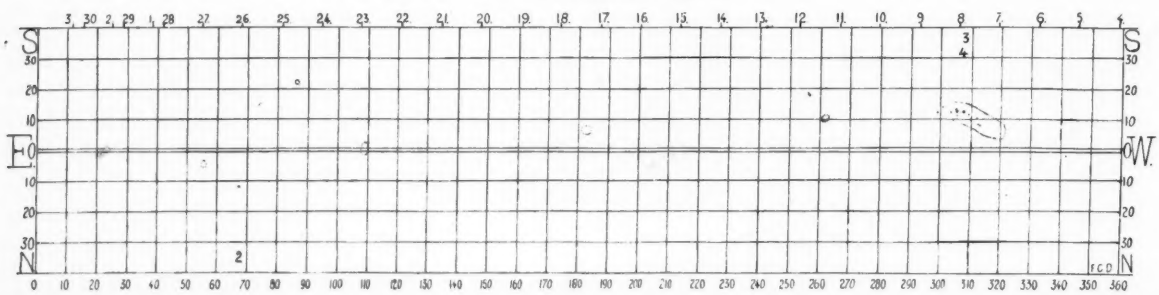
No. 3.—When the faculic area, conspicuous within the eastern limb early in the month, reached the middle of the disc, on the 8th, a line of penumbraless pores developed with bright lips, over 42,000 miles in length, but very soon new pores ahead increased the length to 82,000 miles. On the 9th there was a curve of pores 112,000 miles in length. During the day an ellipse of fourteen spotlets opened within the curve; the outliers soon died out. The rear spotlet increased to 15,000 miles in diameter by the 10th, and a penumbral mass with at least four umbrae formed in front, which for a little while was 21,000 miles in length. During the 11th part of the middle of the group faded away, but it was still a conspicuous object as it neared the western limb on the 14th. The figure on the chart was that of April 9th.

No. 4.—Was a spotlet with about three umbrae amid the faculae within the eastern limb on 30th, other pores south and west were seen on May 1st. On the 2nd a little group of pores, 29,000 miles by 22,000 miles, was seen. There were other changes noted on the 3rd, 4th, and 6th, but it was not seen on the 5th, and on the 8th only a solitary pore was visible apparently just west of the place of the group, but it had gone on the 9th.

On the day of the Eclipse there were no striking disturbances on the disc, and the weather was all that could be desired. There were some interesting prominences upon the limb, which were first covered and then uncovered by the advancing moon. Beyond the cusps of the crescent in the middle of the eclipse the chromospheric lines stood out beautifully in the spectrum. About the same time three separate observers for a short time thought the lunar limb appeared projected upon the corona, but each fancied the appearance might be due to an optical illusion.

The chart is constructed from the combined observations of Messrs. J. McHarg, A. A. Buss, E. E. Peacock, W. H. Izzard, D. Booth, and the writer.

DAY OF APRIL, 1912.



THE ULTRA-MICROSCOPE AND ITS APPLICATION TO THE STUDY OF COLLOIDS.

By E. JOBLING.

IT is often imagined, by those unacquainted with either of the sciences of light and microscopy, that it is merely a question of difficulties in construction of the microscope, particularly of the lenses employed, which prevents us from perceiving the very smallest of objects by its aid. Such, however, is not the case. At certain definite limits of size, phenomena intervene which effectually mar every effort at the microscoping of objects with diameter below this limit. The root of the difficulty lies in the phenomenon of light itself. The fact that light is a transverse vibration of appreciable wave length is of slight importance when dealing with the common objects of everyday experience, but immediately the attention is turned to objects of size comparable with this wave length, the mechanism of light propagation assumes tremendous significance. Then it is that the ordinary laws of reflection and refraction are waived in favour of the more subtle, and therefore the more interesting, phenomena of diffraction.

On the commonsense principle that a sea-wave is but little disturbed by a pebble, though profoundly modified when brought up against a sea-wall, it seems reasonable to assert, without further explanation, that an object comparable in size with a wavelength of light cannot be expected to reflect waves which could convey to the eye a distinct impression of its size and shape. True, it does affect a minute disturbance, but of this more anon. Without venturing into a mathematical discussion of a microscope's " resolving power," it will be sufficient to state that one cannot hope to perceive an object whose size lies below one quarter of a wavelength of light, this constituting the limit above referred to.

However, fortunately or unfortunately, scientists have interest in objects much smaller than these. Thus, the ever-increasing subject of colloids demanded an instrument for the direct observation of colloidal particles; and bacteriology, again, found itself hampered for want of a means of visualising the cells and microbes with which it is concerned. The difficulty has been happily surmounted by the introduction of the ultramicroscope, an instrument which, as its name implies, renders it possible to demonstrate to the eye the existence of objects invisible ordinarily to the finest microscope.

This does not imply that the ideas put forward as to the limits of optical resolution have been in the least contradicted, as the following consideration will show. To be seen, an object must either reflect the light by which we see it or be self-luminous. Consider only a very small particle. If it be of a magnitude above the optical limit, it may be seen by virtue of the light it reflects, and its true form can then be perceived. If, however, its magnitude be below this limit, reflection is impossible, and all incident light becomes diffracted, *i.e.*, scattered in all directions. In the latter case, the object emits light exactly as though it were luminous of itself, though under ordinary circumstances it remains invisible because the proportion of light reaching the eye with regard to the incident light is so small. If now means be adopted for concentrating light upon the object, it might be possible, other circumstances being favourable, to make it emit sufficient light to reach visibility. Of course, the object then cannot be seen in the sense that its shape or surface can be observed, but only seen in the sense that its presence is indicated by the light it emits, being observed in the microscope as a minute disc of light. The utilisation of such a concentrated illumination is the fundamental idea underlying the construction of the ultramicroscope.

This principle was foreshadowed by a phenomenon observed long ago by Tyndall, who passed an intense beam of light through the air of an otherwise darkened chamber, when the track of light was made clearly visible by the light diffracted from the minute dust-motes floating in the atmosphere. Ultramicroscopy furnishes an extension of this, a microscope being introduced for the fuller examination of the track of light. Thus, Zsigmondy, in 1900, as part of his observations on some colloidal gold solutions, reflected a cone of light into the solution and examined the apex of the cone through a microscope. Working on the same principle, Siedentopf was led in 1903 to the improvement of the apparatus, with the result that we owe to him the introduction of the modern high-power illuminating arrangements which form the main feature of the instrument.

Naturally, certain conditions require to be fulfilled. In the first place, the most intense illumination possible is necessary to render the smaller particles visible; secondly, to prevent dazzling of the eye and consequent inability to detect the minute light-discs, no illuminating ray must be allowed to fall upon the eye either directly or by reflection; thirdly, in view of the often extreme faintness of the light-discs, the darkest possible background is essential; and lastly, the beam of light must be extremely shallow in the direction of the line of sight, else nothing more definite would be observed than a luminous haze. Only by rigid satisfaction of these conditions can definite results be obtained.

In the light of the above requirements, the following diagrammatic arrangement of the apparatus constituting one of the most delicate forms of the ultra-

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microscope and seen in Figure 242 will be considered. The solar rays are reflected from a heliostat through the slit A into the darkened laboratory in which the apparatus is set up. The light falls on to B, a telescope objective, by which it is concentrated on to the slit C, which is capable of very fine adjustment. D is a screen

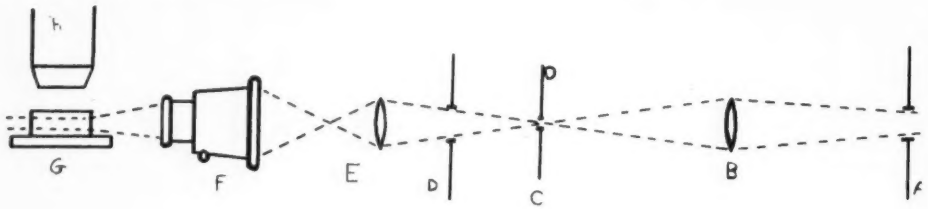

FIGURE 242.

with an aperture of sufficient size to cut off any stray rays of light reflected from the edges of the slit. Another objective, E, directs the light into the condenser F, from which it passes as an intense beam into the solution contained in G. At right angles to the path of light is arranged the microscope H for minute examination of the track of light in G. This latter cell, for the use of solutions, usually takes the form shown in Figure 243, the rectangular part K having quartz faces and being fitted also with a funnel and outlet, which permit of easy washing and filling without disturbing the adjustment.

The above design by Siedentopf of the ultramicroscope is not the only one which has been used. A simpler device, due to Cotton and Mouton, is worthy of note. An oblique parallelopiped of glass, surmounted by the solution and cover slip, is placed upon the stand of the microscope. The convergent illuminating beam follows the course shown in Figure 244, the angle of incidence on the upper surface being adjusted to lie between the critical angles for water-glass and glass-air surfaces and the beam, therefore, is totally reflected. Then, the only light which enters the microscope H is that diffracted by the ultramicroscopic particles of the solution.

For the examination of larger particles, *e.g.*, cells, bacteria, and so on, modified forms of the apparatus may be employed, in which, for convenience, the illuminating rays and the rays diffracted from the particles are in the same straight line. But as these would require complicated designs and descriptions, their consideration is omitted.

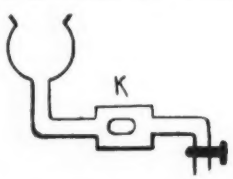

FIGURE 243.

To understand at all completely the beauty of this apparatus, resort must be made to a consideration of several of its more interesting applications. Its possible service to the colloidal chemist and to the bacteriologist has already been hinted at, and we cannot do better than turn our attention to at least one of these applications. Before so doing, a few figures indicating the degree of sensitiveness as compared with other methods of analysis might be deemed interesting. By the aid of spectrum analysis, Bunsen and Kirchhoff consider that $0 \cdot 14 \times 10^{-6}$ mg. of sodium can be detected; whilst, in the case of hydrogen, Emich avers that as minute a quantity as $0 \cdot 7 \times 10^{-13}$ mg. gives appreciable indication of its presence. Again, it is asserted by Fischer that by the sense of smell $2 \cdot 2 \times 10^{-9}$ mg. of mercaptan and by Berthelot that 10^{-11} mg. of iodoform are capable of detection, though here the examples are far and away among the most exceptional that could have been chosen. In the chemical way, too, 3×10^{-7} mg. of sodium hydroxide are able to produce a definite change in the colour of some suitable indicator. With the ultramicroscope, however, a particle of gold of mass 10^{-15} mg. in a gold ruby glass may be observed without trouble, whilst when the most favourable conditions are available, a particle of size ten times that of an average chemical molecule will not escape observation. Obviously, the potentialities of the instrument are great and there is no saying what more astounding results may be expected when the method is still further improved.

APPLICATION TO THE STUDY OF COLLOIDS.

No more fascinating field of enquiry is open to science than the investigation of so-called colloidal solutions. That such a substance as platinum, for instance, generally regarded as insoluble in water, should be capable of forming what appears to be a solution, is certainly striking on first acquaintance. Not only metals, however, but many "insoluble" substances, like silver chloride, can be made to develop this peculiar state by suitable methods. Natural colloids are of universal distribution, the very constituents of living cells appearing to exist in such a form. The properties of a colloidal solution afford a striking contrast to those of ordinary solutions; for instance, their slight ability to diffuse and consequent separation from truly soluble salts by dialysis, their insignificant osmotic pressure, their peculiar electrical properties which seem to point to the presence of an electric charge upon the particles, their capacity for coagulation and absorption, and so on. All these circumstances add an interest to the study of colloids which has served to attract a great host of investigators, as will be gathered from the enormous output of work upon the subject.

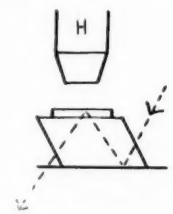

FIGURE 244.

Much controversy has been waged over the exact nature of these colloidal solutions, for they bear

intimately upon the problem of solution in general. Many investigators have been inclined to the idea that they represent perfect solutions, whilst others identify them as suspensions. The intervention of the ultramicroscope has contributed largely to the development of the question, if not to its final solution.

With one or two exceptions, all colloidal solutions on ultramicroscopic examination are found to contain distinct particles, which reveal themselves, as already stated, in diffraction-patches on a grey background. These particles can be counted and their size calculated. There is thus strong evidence for regarding a colloidal solution as merely a limiting case of a suspension. A crystalloidal solution, *i.e.*, the solution of a substance like sodium chloride, gives an absolutely clear field, and one, therefore, infers the absence of even the tiniest particles in a solution of this type. Such a conclusion, however, is questioned by the observations of van Calcar and de Bruyn, who found, for example, that rapid centrifugalisation of a sodium sulphate solution induced partial separation of the salt. From the above reasoning, and further observation but confirms this, it seems impossible to draw any sharp line of demarcation between suspensions, colloidal and crystalloidal solutions, the one class merging imperceptibly into the other. Ultramicroscopic study shows over how wide a range the size of the particles in a colloidal solution varies and renders any attempt at classification of solutions still more unsatisfactory. Indeed, it seems probable that in a solution the size of the "dissolved" particle can vary gradually from that of the ordinary chemical molecule to the dimensions of a visible suspensoid particle, the properties of the resulting solutions varying with the molecular forces called into play.

But more interesting developments even than these can be attributed to the ultramicroscope, for results recently obtained by its aid go far towards strengthening the probability of the Atomic and Molecular Theories. Over a century ago, the naturalist Brown observed that the particles of a fine suspension, when observed under the microscope, are in a continual state of agitation, but the observation was shelved and almost forgotten. It is only in recent years, and mainly by the application of the ultramicroscope, that the further investigation of this interesting phenomenon has been rendered possible.

The ultramicroscope has demonstrated that the smaller the particle the greater the activity, until in colloidal solutions we get a movement so violent as to resemble, in the words of Zsigmondy, "a swarm of dancing gnats." There seems to be some connection between this rapid movement of small bodies and the slower movement of the heavier particles observed by Brown. Indeed, it almost suggests that, if further diminution of the particles be imagined, the attainment of molecular dimensions might give a value for the molecular velocity of an order comparable with that calculated on the theoretical assumptions of the Kinetic Theory; in other words, that the kinetic energies of a molecule and of a colloid or suspensoid particle are equal. This view has developed almost into a certainty, particularly by Perrin's remarkable investigations, and an experimental verification of the Kinetic Theory is thus forthcoming.

A brief outline of Perrin's work will serve not only as a development of the above brilliant idea, but also as a fitting demonstration of the methods employed in ultramicroscopic research.

In the first place, his investigations required a colloidal solution, the particles of which were of the same size, and this was rendered possible by the method of "fractional" centrifugalisation. The uniform solution, after dilution and standing for some time, was then examined ultramicroscopically, the microscope being focussed on an extremely shallow beam of light capable of vertical movement. At positions corresponding to different heights of the solution, an estimate of the number of particles was accurately made. This, of itself, is an extremely laborious undertaking. The particles illumined by the beam are visible in the field of the microscope, but are executing their Brownian dance, and it is impossible to make even an approximate computation of their number. The difficulty is overcome by the use of one of two methods. Either the field of view is instantaneously photographed several times and the mean number taken; or a stop is inserted in the microscope so as to limit the field to contain only a few particles, and then, by means of a shutter, instantaneous "peeps" are obtained at small intervals, the number of observed particles being noted at a glance, and subsequently the mean of several thousand of these readings taken. Both methods give very concordant results. Having ascertained the number of particles corresponding to different heights in the solution, examination showed that these were, within the limits of experimental accuracy, exactly in geometrical progression.

Thus, at heights 100 75 50 25 microns,
the numbers 200 170 146 116 were obtained,
whilst 201 169 142 119 are in exact

geometrical progression. Such results demonstrated beyond doubt that the particles reach a state of equilibrium where their distribution corresponds to that of the molecules of a fluid. Thus, in the atmosphere, the concentration of the constituents gradually diminishes as we ascend, the diminution obeying the above exponential law. The only difference between the two cases is that whilst the atmosphere requires a rise of six kilometres for the halving of the concentration, a colloidal solution requires about one-tenth of a millimetre.

Having proved that such an experimental law was applicable to colloidal solutions, a mathematical expression was easily deduced by which, given the density of a particle, its mass and the number per unit volume, the Kinetic Theory constant—which denotes the number of molecules per gram-molecule of any compound—is calculable. For the present purpose it is not necessary to go into the mathematics

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of the case. Sufficient that the mass is now the only unknown which prevents us from solving the problem, and this is deduced by the application of Stoke's law, which gives an expression for the velocity of a sphere as it sinks through a viscous fluid. The velocity of fall of colloidal particles in a capillary tube, as they descended to take up their final distribution, was carefully observed and by substitution in Stoke's equation the mass of the particles calculated.

Everything is now ready for the determination of the Kinetic Theory constant. On the basis of this theory, the constant has been worked out to be 7×10^{-23}. Judge of the interest and importance of the above investigation, absolutely experimental throughout, when the value of the constant was found to be $6 \cdot 9 \times 10^{-23}$. Since then, more accurate determinations have been made and it seems that the above method comprises a means for the determination of that fundamental constant, the number of molecules per gram-molecule, which is capable of almost unlimited precision. The gas-laws, already applied by van't Hoff to dilute solutions, are thus extended by Perrin to uniform emulsions. In addition, his researches form no mean part of the evidence which has lifted the "molecule" out of hypothesis into reality.

Enough has been said to indicate the wide scope of application of the ultramicroscope, and there is every reason to believe that this scope will be considerably extended in the near future. Even now we hear of such developments as the cinematographing of the particles visible by its aid, particularly blood-corpuscles and attendant disease-germs. Certainly it is to this apparatus that we look for further information regarding the nature of protoplasm and the problem of living matter, it being reserved for future reviewers to say whether or no these expectations have been realised.

CORRESPONDENCE.

ON THE RESEMBLANCE OF THE FLORA AND FAUNA OF IRELAND TO THAT OF THE SPANISH PENINSULA.

To the Editors of "KNOWLEDGE."

SIRS,—In the very interesting article by Dr. Scharff in the March number of "KNOWLEDGE," he mentions that the beetle, *Rhopalomesites tardzi*, occurs only in the south-west of England. It may perhaps interest some of your readers to know that I have taken it in some numbers in the neighbourhood of Hastings. It occurred in an old holly hedge which had been cut back repeatedly, apparently for many years. This hedge was perhaps twenty yards long, and the old stumps were full of the burrows. I am under the impression that the perfect insects occurred only in the branches which had been topped two years before, but of this I am not sure. A row of holly trees which had been allowed to grow unchecked a few yards further on yielded no specimens, though carefully searched. The same is true of many other holly hedges that I searched in vain in the district. The specimens varied very much in size, but the largest was less than half the size of Irish specimens that I have seen.

WM. WILLS ESAM, B.A.

THE SPECTROSCOPIC ASPECT OF IMPACT THEORY.

To the Editors of "KNOWLEDGE."

SIRS,—I was very pleased with Mr. Raffety for his extremely clear statements of the many difficulties in the way of a full detailed interpretation of the spectra of novae. I wish also to thank him for showing so clearly how remarkably the theory of the third body explains all the generic peculiarities.

There are so many chemical and physical agencies at work that the spectrum lines of the first elements will hardly be likely to show speeds corresponding to the law of Graham. Immediately after the impact the molecular speeds will be all alike; hence we have to remember that the temperatures given at collision by the conversion of moler into molecular motion is inversely as the atomic weights. These great differences can only be partially equalised. We have also to remember that is the first state of a third body, the light gases are at the centre—exactly opposite to that of an ordinary star—and that the centre must be enormously cooler than the surface.

The spindle form of the third body would have atomic weights from one to ten at centre; from ten to forty at outside and from forty to eighty at its ends. The escaping gases from the centre will lower the temperature of the elements on the outside, but not of the ends; hence iron, titanian, and so on, may actually show a higher velocity than sodium or potassium, and, as the brilliant nucleus will not generally be shining through the ends, the iron lines will show no reversal on the edge towards the violet. All the deductions have not been able to be observed. But every portion and every characteristic that can be observed correspond. The correspondences are so numerous and so singular, so abnormal, as absolutely to demonstrate the fact that Nova Persei was certainly a third star struck from grazing suns. It is satisfactory to know that an astronomer of repute at the last meeting of the Royal Astronomical Society said "that he thought that Professor Bickerton's conclusions were sound and that the very sudden flare-up of novae indicated the collision of two tolerably condensed bodies."

HYDE PARK, W. A. W. BICKERTON.

THE MECHANISM AND USE OF THE APOPHYSES OF THE SCALES OF THE CONES OF THE SCOTS PINE.

To the Editors of "KNOWLEDGE."

SIRS,—The thick tip of the apophyses is covered with hardened resin, but the broad thick part below the tip consists of spongy cork-cells with several vascular cords running through it. The outer surface is striated, and water readily penetrates it and saturates the spongy cork.

The inner side of the scale tapering to the base consists of a compact layer of thick-walled fibres with a wavy outline.

If the apophyses only be kept in water they soon become saturated; on the other hand, the fibrous layer will presumably tend to contract by shortening the fibres. At all events, the result is that the scales of a cone, in which they are widely spread out, now all contract and the cone closes up tight.

We thus see why, after fertilisation of the ovules, the apophyses of the green scales, filled with sap, close up and protect the developing ovules. After all, the moisture has been utilised for the ovules, presumably carried down by the vascular cords penetrating the corky tissue of the apophyses. Then the scales expand, being dried up, and the now ripe seeds are liberated. When the cone finally falls to the ground all the scales are spread out, but if the soil be wet the apophyses re-absorb moisture, and the scales close up again.

GEO. HENSLOW.

HOW TO MAKE STEREOSCOPIC STAR CHARTS.

By A. H. STUART, B.Sc., F.R.A.S.

A FEW years ago, an American firm placed upon the market a series of star charts arranged as stereoscopic slides, so that in the stereoscope they present the very beautiful appearance of shewing the stars in relief. Very few of these slides seem to have found their way into England. Much instructive pleasure may be derived by preparing these slides for oneself. For this purpose we must be able to determine the position of the stars as they appear to

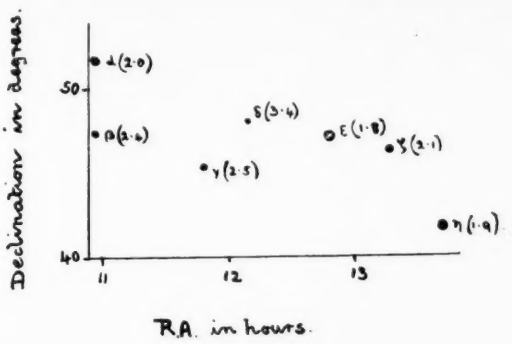

FIGURE 245.

us, and we must also have some knowledge of their relative distance from us. The first of these requirements is supplied by a knowledge of the star's right ascension and declination, which may be taken from the *Nautical Almanac* or similar publication. The relative distance of the stars would be best given by their parallax, but as the vast majority of stars are too remote to shew any parallax, their relative distances have to be estimated by a consideration of their type, magnitude, and so on.

The method of preparing a slide will be best demonstrated by taking a concrete example. Suppose we take the constellation *Ursa Major*, using the magnitude only as an indication of distance. Table 20 is prepared by consulting *The Nautical Almanac*.

It will be wise, at any rate for the beginner, to make a preliminary diagram similar to that shewn in Figure 245. Trouble is saved if this operation is performed on squared paper. The vertical scale is one of declination and the horizontal one shews the right ascension. These two scales must be so proportioned that the diagram shews the stars in much the same relative positions as they appear in the heavens. Now right ascension is, of course, given in hours, while declination is given in degrees, and as twenty-four hours are equivalent to three hundred and sixty degrees, we have one hour of right ascension equivalent to fifteen degrees of declination. This, however, is only true at the equator, the great (hour) circles converging as we approach the poles. It is easy to see that the distance between a pair of these circles at any place compared with the distance measured along the equator is proportional to the cosine of the declination. If the constellation we are plotting is not too large, we may take the cosine of the mean declination

URSA MAJOR.

Designation.		Magnitude.		Right Ascension.		Declination.
β	...	2·4	...	$10^h\ 56^m$	...	56° 52′
α	...	2·0	...	10 58	...	62 14
γ	...	2·5	...	11 48	...	54 11
δ	...	3·4	...	12 10	...	57 32
ϵ	...	1·8	...	12 49	...	56 27
ζ	...	2·1	...	13 20	...	55 23
η	...	1·9	...	13 43	...	49 45

TABLE 20.

for our adjustment without introducing any sensible error. Now the mean declination of the stars in *Ursa Major* is about 50°, and cos. 50° = ·643. Suppose we decide to represent one degree of declination by a distance of two millimetres, then at the equator one hour of R.A. would have to be represented by $2 \times 15 = 30$ millimetres. But at the declination of *Ursa Major* this distance becomes $30 \times \cdot 643 = 19 \cdot 3$ millimetres. Thus Figure 245 is

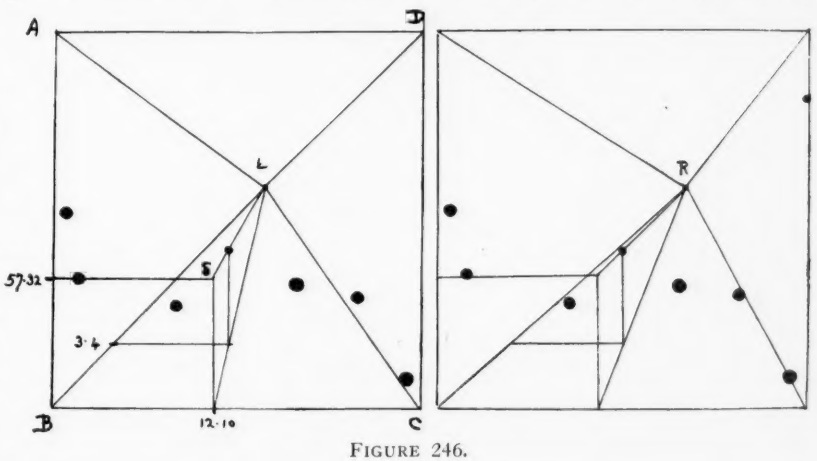

FIGURE 246.

drawn, using a scale of two centimetres to 10° of declination, and 1·93 centimetres to one hour of R.A.

Having settled this matter, the next thing is to

prepare the diagram shewn in Figure 246. This consists of two squares drawn close together and whose sides are sufficiently long to take the scales of declination and R.A. In these squares are constructed the two views which go to form the stereoscopic slide. Now we have to consider the matter in three dimensions and the squares represent the two dimensions in the plane of the paper. The third dimension, at right angles to the plane of the paper, must now be represented. To do this select a point about the middle of the left-hand square, which will be the vanishing point of all the lines in that square running at right angles to the plane of the paper. To fix the corresponding point in the other square draw a horizontal line through this point and measure along it towards the right-hand figure a distance equal to the distance between the two eyes (about three inches); this will be the required point. These points are lettered L and R in Figure 246 because L is the vanishing point for the view obtained by the left eye and R that for the right eye. The four corners of the square should now be joined to the corresponding vanishing point. It will be well to examine the drawing in a stereoscope at this stage to make sure that all is right. The view obtained should have the appearance of looking down a very long square tunnel. None of the lines should appear double. We will now consider the construction about the left-hand figure only, it being understood that a similar construction on the right-hand figure is necessary. Along the line BL a scale must be made to indicate depth in the figure. In our case this must correspond to stellar magnitude. It is wise to make this scale short compared with the length BL. The graduations on this scale must in each diagram be proportional to the cosine of the angle corresponding to LBC. A simple method of securing this is to drop a perpendicular from C on to the line BL and take a portion of the distance from B to the foot of the perpendicular, and divide it into a suitable number of equal parts. In Figure 246 one-third of this distance was taken and divided into eight equal parts. The point B then represented the graduation for magnitude 1·8, and each subsequent graduation indicated an increase of ·2 in magnitude. It must be clearly understood that this scale in the left-hand figure will be different from that in the right-hand figure; each scale must be constructed independently.

The position of each star in Figure 246 has been fixed by the same method, but in order to make the matter more clear, the construction for fixing the position of one star only (*viz.*, δ *Ursae Majoris*) is shewn. For convenience of reference we will call the line BC (along which the scale of R.A. is made) the axis of x, and the line BA (along which the scale of declination is made) the axis of y. The line BL, on which we have our magnitude scale, we will call the axis of z. First fix the position of the star, as it appears in Figure 245, by drawing a line from declination $= 57° 32'$ parallel to the axis of x, until it meets the line drawn from R.A.$=12^h\ 10^m$ parallel to the axis of y. Call this point δ. From the point on the axis of z, corresponding to magnitude 3·4, draw a line parallel to the axis of x until it meets the line running from point R.A.$=12^h\ 10^m$ to L. From this point of intersection draw a line parallel to the axis of y, until it meets the line running from δ to L. This last point is the position of the star in the diagram. It will be remembered that we took the point B, on the axis of z, as representing magnitude 1·8, which is that of ϵ *Ursae Majoris*, the brightest star in the constellation. The fixing of the position of this star in the diagram is particularly easy, as it requires no reference to the axis of z at all. A very little practice is sufficient to enable one to make these slides with great ease and rapidity.

It is a great advantage if the construction is done on drawing paper, and the final positions of the stars pricked through on to the final slide, which then shews none of the construction lines. The slides present a much more attractive appearance if they are of black paper, and the position of the stars marked by spots of Chinese white.

NOTICES.

THE ARGENTINE METEOROLOGICAL OFFICE.—In an article which the Director, Mr. Walter G. Davis, has contributed to *Symons's Meteorological Magazine* for April, we learn that the Meteorological Service in the Argentine Republic was established in the year 1872. At the present time it consists of thirty-five stations of the first order, equipped with self-registering instruments; one hundred and fifty-six of the second order, where observations are made at 8 a.m., 2 p.m., and 8 p.m.; ten of the third order similar to the second but without barometer, and one thousand six hundred rain gauge stations.

THE TITANOTHERES.—The front page of *The Scientific American* for April 6th, 1912, is occupied by a photograph of the restored head of the largest of the Titanotheres—giant-horned monsters allied to the Rhinoceroses. Some of the animals averaged eight feet high at the shoulder, and sixteen feet in length. For comparison there is also shown in the picture a restored head of an ancestral member of the family, quite hornless, and about the size of the smallest Shetland pony. The heads form part of an exhibit which is being installed in the hall of Vertebrate Palaeontology, in the Museum of Natural History, New York.

BEHAVIOUR OF METALLIC ALLOYS WHEN HEATED IN A VACUUM.—*The Chemical News* gives a summary of experiments by Messrs. Clarence Richard Groves and Thomas Turner, from which it appears that two or more metals may volatilise together. Thus lead and zinc tend to pass over together. In the iron-zinc series also there is an increasing proportion of the iron carried over as the temperature rises from 500°. In the silver-zinc series, although separation is nearly quantitative at 700°, there is an increased loss of silver with higher temperatures.

THE FACE OF THE SKY FOR JULY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

Date.	Sun. R.A.	Sun. Dec.	Moon. R.A.	Moon. Dec	Mercury. R.A.	Mercury. Dec.	Venus. R.A.	Venus. Dec.	Jupiter. R.A.	Jupiter. Dec.	Uranus. R.A.	Uranus. Dec.
Greenwich Noon.	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	
July 4	6 52·6	N.22·9	22 36·6	S. 12·3	8 11·3	N.21·9	6 50·9	N.23·5	16 20·4	S.20·8	20 18·7	S.20·2
,, 9	7 13·2	22·4	2 22·0	N.16·1	8 45·6	19·5	7 17·6	23·0	16 18·7	20·7	20 18·0	20·3
,, 14	7 33·5	21·7	7 33·9	N.26·8	9 15·1	16·8	7 44·1	22·2	16 17·4	20·7	20 17·2	20·3
,, 19	7 53·7	20·9	12 19·4	S. 1·0	9 40·1	14·0	8 10·2	21·2	16 16·3	20·7	20 16·3	20·4
,, 24	8 13·7	19·9	16 28·4	S. 25·9	10 0·4	11·3	8 35·9	19·9	16 15·5	20·6	20 15·5	20·4
,, 29	8 33·4	N.18·8	20 52·5	S. 22·3	10 15·6	N 8·8	9 1·1	N.18·3	16 15·1	S.20·6	20 14·7	S.20·5

TABLE 21.

Date.	Sun. P	Sun. B	Sun. L	Moon. P	Jupiter. P	Jupiter. B	Jupiter. L_1	Jupiter. L_2	Jupiter. T_1	Jupiter. T_2
Greenwich Noon.	°	°	°	°	°	°	°	°	h m	h m
July 4	− 1·2	+3·3	235·2	−20·7	+ 9·6	−2·9	84·4	172·7	9 42 *m*	7 14 *m*
,, 9	+ 1·0	3·9	169·0	−17·5	9·8	2·8	154·0	204·3	7 43 *m*	4 18 *e*
,, 14	3·3	4·4	102·8	+ 9·0	9·9	2·8	223·6	235·7	5 44 *e*	3 26 *e*
,, 19	5·5	4·8	35·7	+21·8	10·0	2·8	293·1	267·0	4 0 *m*	4 39 *m*
,, 24	7·7	5·3	330·5	+ 8·0	10·1	2·8	2·4	298·2	9 47 *e*	11 39 *e*
,, 29	+ 9·8	+5·7	264·4	−15·3	+10·2	−2·8	71·7	329·3	0 12 *m*	2 50 *m*

TABLE 22.

P is the position angle of the North end of the body's axis measured eastward from the North Point of the disc. B, L are the helio-(planeto-)graphical latitude and longitude of the centre of the disc. In the case of Jupiter L_1 refers to the equatorial zone, L_2 to the temperate zones. T_1 T_2 are the times of passage of the two zero meridians across the centre of the disc; to find intermediate passages apply multiples of $9^h\ 50\frac{1}{2}^m$, $9^h\ 55\frac{1}{2}^m$ respectively.

The letters *m*, *e* stand for morning, evening. The day is taken as beginning at midnight.

THE SUN is moving South again. It is at its greatest distance from the Earth July $4^d\ 11^h$ *e*, its semi-diameter is then 15′ 45″·35, and 15′ 47″·0 on July 31st. Sunrise varies from $3^h\ 49^m$ to $4^h\ 24^m$; sunset from $8^h\ 18^m$ to $7^h\ 49^m$.

MERCURY is an evening star; it is in elongation, 27° from Sun July 25th. Semi-diameter increases during month from $2\frac{3}{4}''$ to $4\frac{1}{4}''$; fraction of disc illuminated diminishes from 0·8 to 0·4.

VENUS is in superior conjunction with Sun July 5th, and its disc is therefore fully illuminated, semi-diameter 4″·9.

THE MOON.—Last Quarter July $7^d\ 4^h\ 47^m$*e*; New $14^d\ 1^h\ 13^m$*e*; First Quarter $21^d\ 5^h\ 18^m$ *m*; Full $29^d\ 4^h\ 28^m$*m*. Apogee $2^d\ 1^h$*m*, semi-diameter 14′ 44·2″; Perigee $14^d\ 12^h$ *e*, semi-diameter 16′ 44·3″; Apogee $29^d\ 5^h$*m*, semi-diameter 14′ 43·5″. Minimum Librations, July 9^d, 7° E., 14^d 7° S., 21^d 8° W., 27^d 7° N. The letters indicate the region of the Moon's limb brought into view by libration. E. W. are with reference to our sky, not as they would appear to an observer on the Moon.

MARS is too near the Sun for useful observation; it is still an evening star.

JUPITER is an evening star. Its equatorial semi-diameter varies from 22″ to $20\frac{1}{2}''$, the polar is smaller by $1\frac{1}{2}''$. The configurations of the satellites at 10^h *e* are for an inverting telescope (see Table 24).

Satellite phenomena visible at Greenwich, $2^d\ 8^h\ 42^m\ 56^s$*e* III. Ec. R., $11^h\ 18^m$*e* II. Tr. I.; $3^d\ 0^h\ 42^m$*m* II. Sh. I.; $4^d\ 0^h\ 27^m$*m* I. Tr. I., $1^h\ 12^m$*m* I. Sh. I., $9^h\ 44^m$*e* I. Oc. D.,

Date.	Star's Name.	Magnitudes.	Disappearance. Mean Time.	Disappearance. Angle from N. to E.	Reappearance. Mean Time.	Reappearance. Angle from N. to E.
1912.			h m		h m	
July 2	BAC 7180	7·2			0 19 *m*	271°
,, 2	37 Capricorni	5·7	11 15 *e*	121°	0 2* *m*	195
,, 3	ϵ Capricorni	4·7	1 5 *m*	25	2 11 *m*	280
,, 6	BD—5° 6048	7·5			0 7 *m*	241
,, 10	ρ^2 Arietis	6·0			0 37 *m*	255
,, 11	33 Tauri	6·0	1 39 *m*	52	2 29 *m*	266
,, 11	BAC 1238	6·5	3 9 *m*	121	3 44 *m*	194
,, 18	β Virginis	3·8	8 38 *e*	137	9 33 *e*	284
,, 23	BAC 5286	5·4	7 43 *e*	34	8 2 *e*	7
,, 30	33 Capricorni	5·3	0 55 *m*	121	1 33 *m*	178

TABLE 23. Occultations of stars by the Moon visible at Greenwich.

The asterisk indicates the day following that printed in the date column.
From New to Full disappearances take place at the Moon's Dark Limb, from Full to New reappearances.

$9^h\ 47^m\ 7^s e$ II. Ec. R.; $5^d\ 0^h\ 40^m\ 7^s m$ I. Ec. R., $9^h\ 7^m e$ I. Tr. E., $9^h\ 54^m e$ I. Sh. E.; $9^d\ 9^h\ 17^m e$ III. Oc. R., $10^h\ 38^m\ 43^s e$ III. Ec. D.; $10^d\ 0^h\ 42^m\ 29^s m$ III. Ec. R.; $11^d\ 11^h\ 30^m e$ I. Oc. D.; $12^d\ 0^h\ 24^m\ 37^s m$ II. Ec. R., $8^h\ 42^m e$ I. Tr. I., $9^h\ 36^m e$ I. Sh. I., $10^h\ 55^m e$ I. Tr. E., $11^h\ 49^m e$ I. Sh. E.; $13^d\ 9^h\ 3^m\ 17^s e$ I. Ec. R.; $16^d\ 10^h\ 42^m e$ III. Oc. D.; $17^d\ 0^h\ 49^m m$ III. Oc. R.; $18^d\ 10^h\ 22^m e$ II. Oc. D.; $19^d\ 10^h\ 31^m e$ I. Tr. I., $11^h\ 31^m e$ I. Sh I.; $20^d\ 9^h\ 50^m e$ II. Sh. E., $10^h\ 57^m\ 52^s e$ I. Ec. R.; $21^d\ 8^h\ 13^m e$ I. Sh. E.; $27^d\ 8^h\ 21^m e$ III. Sh. I., $9^h\ 35^m e$ I. Oc. D., $9^h\ 43^m e$ II. Sh. I., $10^h\ 12^m e$ II. Tr. E., $10^h\ 40^m e$ III. Sh. E.; $28^d\ 7^h\ 55^m e$ I. Sh. I., $9^h\ 1^m e$ I. Tr. E., $10^h\ 9^m e$ I. Sh. E.

Phenomena separated by a comma occur on the same day.

July 27th is worthy of attention, the shadows of II. III. being simultaneously on the disc, while I. is occulted at the same time.

The Eclipse reappearances of I, II and disappearances and reappearances of III, occur high right of the inverted image, taking the direction of the belts as horizontal.

SATURN is a morning Star, too near the Sun for convenient observation.

URANUS is in opposition on the 24th, and is therefore in its best position for the present year. It is well placed for southern observers. Semi-diameter 2″. It is 5° south of Beta Capricorni.

NEPTUNE is invisible, being in conjunction with the Sun on the 16th.

METEOR SHOWERS (from Mr. Denning's List):—

Date.	Radiant. R.A.	Radiant. Dec.	Remarks.
May to Aug.	333°	+ 28°	Swift, streaks.
May to July	252	− 21	Slow, trains.
June to Aug.	310	+ 61	Swift, streaks.
June to Sept.	335	+ 57	Swift, slow in Sept.
June, July ...	245	+ 64	Swift.
June to Aug.	303	+ 24	Swift.
July 6—22 ..	284	− 13	Very slow.
,, 15—31 ...	23	+ 43	Swift, streaks.
,, 19	315	+ 48	Swift, short.
,, 22—27 ...	335	+ 51	Swift, streaks.
July, Aug. ...	308	− 12	Slow, long.
July 25 to Sept. 15	48	+ 43	Swift, streaks.
July 28	339	− 11	Slow, long, conspicuous shower, the July Aquarids.
July to Sept.	335	+ 73	Swift, short.
July 8—31 ...	317	+ 31	Swift, white.
July, Aug. ...	280	+ 57	Slow, short.
July to Oct....	355	+ 72	Swift, short.

The Perseids may be seen from July 19, radiant 23° + 52°, it advances 1° per day in R.A.

Day.	West.	East.		Day.	West.	East.	
July 1	34 ○	12		July 17	2 ○	413	
,, 2	41 ○	23		,, 18	412 ○	3	
,, 3	42 ○	13		,, 19	4 ○	132	
,, 4	4 ○	23	1●	,, 20	432 ○		1●
,, 5	41 ○	32		,, 21	4321 ○		
,, 6	432 ○	1		,, 22	43 ○	$\frac{3}{1}$	
,, 7	$43\frac{2}{1}$ ○			,, 23	413 ○	2	
,, 8	$\frac{4}{3}$ ○	12		,, 24	42 ○	13	
,, 9	1 $\frac{4}{3}$ ○	32		,, 25	412 ○	3	
,, 10	2 ○	143		,, 26	○	$\frac{1}{1}$ $\frac{2}{3}$	
,, 11	1 ○	34	2●	,, 27	3 ⊙	4	1●
,, 12	⊙	324		,, 28	321 ○	4	
,, 13	32 ○	14		,, 29	3 ○	$\frac{2}{1}$ 4	
,, 14	321 ○	4		,, 30	$\frac{3}{1}$ ○	24	
,, 15	3 ○	124		,, 31	2 ○	134	
,, 16	13 ○	24					

TABLE 24.

CLUSTERS AND NEBULAE.

Name.	R.A.	Dec.	Remarks.
M. 9	$17^h\ 14^m$	S 18°·4	Small cluster.
M. 92	17 14	N 43 ·3	Fine cluster.
M. 14	17 32	S 3 ·2	Large faint cluster.
M. 23	17 51	S 19 ·0	Diffused cluster.
⊞ IV. 41	17 56	S 23 ·0	Trifid nebula.
M. 8	17 58	S 24 ·4	Loose cluster in rich region of galaxy.
⊞ IV. 37	17 59	N 66 ·6	Planetary nebula. First one tested by Huggins with spectroscope. Marks pole of Ecliptic.
⊞ VII. 30	18 7	S 21 ·6	Ill-defined cluster.
M. 28	18 18	S 24 ·9	Faint cluster. 1° N. of λ Sagittarii.
⊞ VIII. 72	18 23	N 6 ·5	Fine cluster.
M. 25	18 26	S 19 ·2	Coarse cluster.
M. 22	18 30	S 24 ·0	Bright cluster. Between μ and σ Sagittarii.
H 202 H.	18 45	N 10 ·2	Cluster.

DOUBLE STARS.—The limits of R.A. are 17^h to 19^h.

Star.	Right Ascension. h. m.	Declination.	Magnitudes.	Angle. N. to E.	Distance.	Colours, etc.
μ Draconis	17 4	N 54°·6	5, 5	140°	2″	White.
α Herculis	17 11	N 14 ·5	3, 6	113	5	Yellow, blue.
ε Herculis	17 21	N 37 ·2	$4\frac{1}{2}$, $5\frac{1}{2}$	314	4	Greenish.
Σ 2173	17 26	S 1 ·0	6, 6	180	$\frac{1}{2}$	Yellow.
61 Ophiuchi	17 40	N 2 ·6	5, 6	93	21	Period 46^y. White.
μ Herculis	17 43	N 27 ·8	4, 9	245	32	Yellow, blue.
μ Herculis; faint star ..	17 43	N 27 ·8	9, 10	103	$\frac{3}{4}$	
ψ Draconis	17 43	N 72 ·2	4, 5	15	31	White.
τ Ophiuchi	17 58	S 8 ·2	5, 6	260	$1\frac{1}{2}$	Yellowish.
95 Herculis	17 58	N 21 ·6	5, 5	260	6	Green, red.
70 Ophiuchi	18 1	N 2 ·5	4, 6	150	3	Yellow, purple.
	Motion disturbed, probably by an invisible companion.					
40 and 41 Draconis ...	18 7	N 80 ·0	5, 6	233	20	Yellow.
5 Aquilae	18 42	S 1 ·1	6, 7	121	13	White, blue.
ε ^{1}Lyrae	18 42	N 39 ·6	5, 6	12	3	Green, blue.
ε ^{2}Lyrae	18 42	N 39 ·5	5, 5	127	2	White.
	These two pairs form the "Double-double."					
θ Serpentis	18 52	N 4 ·1	4, 4	103	22	Yellow.

TABLE 25.

THE KNOWLEDGE OF METALLIC BADGES, TICKETS AND PASSES.

By A. M. BROADLEY.

Author of "The Royal Miracle."

FROM the consideration of those medals which are exclusively commemorative and historical in their

FIGURE 247.
Badge of Charles I and Henrietta Maria, distributed on the occasion of their marriage.

character, and were generally preserved by their purchasers in cases and cabinets, we pass to another class which, when worn or exhibited, served to indicate the political sympathy or opinions of the owner; to denote the membership of some particular club, association or fraternity; to procure admittance to a theatre, concert room or social gathering, or to testify to the successful accomplishment of some mental or physical achievement. In most instances medallions of this kind are provided at the upper end with a loop or ring through which a ribbon could be conveniently passed. The custom of displaying them on the breast is, however, not universal. We have a notable exception in the trophy of the waterman alluded to by Charles Dibdin in the familiar lines:—

> Then farewell, my trim-built wherry
> Oars, and coat, and *badge* farewell.

The winner of Doggett's "badge" (a facsimile of which is embossed in gold on the cover of the admirable work of Messrs. T. A. Cork and Guy Nickalls, dealing with the history of the annual contest since 1714) wears the outward and visible sign of victory on his right arm. Thomas Rawlings was the maker of some of the beautiful badges which were distributed on the occasion of the marriage of King Charles I and Queen Henrietta Maria, with a view, apparently, to their being worn by the recipients. I am enabled, by the courtesy of Messrs. Spink, to reproduce two examples of these charming medallions. In the first (see Figure 247) we have the the bust of Charles I, to right, hair long, falling lace collar, doublet buttoned close, scarf across the breast. Legend incuse—CAROLVS. D. G. MAG. BRI. FR. ET. HIB. RX.

Reverse: Bust of Henrietta Maria, to left, hair flat at the top, curly at the sides, drawn through a small coronet behind and tied into a bow, pearl necklace and pendant, figured bodice with brooch in front, bust terminated in drapery. Legend—HENRETTA. MARIA. D. G. MAG. BRITAIN. FRAN. ET. HIB. REG. Below, T. Rawlins. F. Size—1·45 by 1·15.

In the second variety (see Figure 248) we see the bust of Charles I, l., laureate, hair long, in armour with lion's head on shoulder, medal suspended to a chain, and mantle festooned upon the breast. On the reverse is the bust of Henrietta Maria, l., hair flat at the top, curly at the sides drawn through a coronet behind, and tied into a bow, pearl necklace and pendant, figured bodice with brooch in front, bust terminated in drapery. In this case there is no legend, but we have neat floral and corded borders on both sides. Size 1·25 by 1. In both instances there are rings for suspension, but this medal occurs without the borders. These pieces are both by Thomas Rawlings.

FIGURE 248.
A smaller Badge of Charles I and Henrietta Maria.

Exceeding scarce is the medallion worn as a memento of that gallant gentleman, Sir Henry Slingesby, who was be-

FIGURE 249.
A very rare Medallion commemorating Sir Henry Slingesby who was beheaded in 1658.

headed in 1658, a specimen of which is in the collection of Messrs. Spink (see Figure 249). It is thus described:—Half-length figure of Sir Henry Slingesby, nearly full face, hair long, in armour and sash round his waist. Outer Legend — EX. RESIDVIS. NVMMI. SVB. HASTA. PIMMIANA. LEGE. PRÆ DATI. IVXTA. DAVENTRIAM. (From the residue of the money plundered near Daventry under the military authority of Pym.) Inner Legend — AN. EARNEST. PENNY. FOR. MY. CHILDREN. THO: H: B: SLINGESBY. B. OXON. 1644. Reverse engraved. Armorial shield with mantling and crest, Slingesby impaling Belasyse. Below, beheaded Iun: $\frac{e}{y}$: 8: by O: C: 1658. Size — 1·85 by 1·55. Cast, untouched by the graver: ring for suspension. This badge has a very special interest for York collectors for Sir Henry Slingesby belonged to an ancient family in that county. He was attached to the royalist party, and having been made prisoner, was, after two years' confinement at Hull, brought up to London and executed on Tower Hill, 8th June, 1658; or, as it is stated in the Harl. M.S. 4630, "he was condemned by a High Court of Justice, as it was then called, upon the information of one Rafe Waterhouse, a very mean person, and beheaded or basely murthered." He had married Barbara,

FIGURE 250.

Loyalist Badges and Medals associated with the adventures of Charles II between 1649 and 1660. Arranged by Messrs. Spink for the collection of A. M. Broadley.

daughter of Thomas Belasyse, Viscount Fauconberg, and aunt to Thomas, Lord Fauconberg, the husband of Mary, daughter of Cromwell, and had issue the three children, Thomas, Henry, and Barbara, for whom this medal was made. After the surrender of York, Sir Henry Slingesby, with a portion of the army, made his way to Oxford, where he arrived after many perils, especially from an attack of the rebel horse near Daventry, where he lost all that he had. At Oxford he had his quarters with Sir William Parkhurst, Master of the Mint, which may account for the execution of this medal. It is probably the work of Thomas Rawlings.

FIGURE 252.
Portrait Badge of Prince Charles Edward, 1745.

FIGURE 251.
The Badge of the Loyal Association of 1745.

In my book, "The Royal Miracle," just published by Mr. Stanley Paul, I have described at length the various badges worn or preserved between 1649 and 1660 by the loyal adherents of the exiled King. The entire series of these interesting medals in my collection is now reproduced (see Figure 250). In the centre will be seen a small miniature painting of the fugitive Charles, executed on copper, which has been pierced at the upper end, evidently to facilitate its being worn by the original owner. It is possible that other examples of these loyalist badges are in the Stuart collection of Miss Helen Farquhar.

It is curious to contrast the two badges of 1745, both of which are now illustrated. On one we have a very fair portrait of the Young Pretender (see Figure 252). Its object is sufficiently obvious. England and Austria were closely allied during the war of the Austrian succession (1741–1748), and at this critical juncture, especially in 1745, many associations were formed to support the reigning House of Hanover. The badge or medal of the Loyal Association of 1745 (see Figure 251) is thus described:—Round it runs the legend, WHERE HEARTS ARE RIGHT, LET HANDS UNITE. Two men grasp hands. Ex. FOUNDED IN THE FRENCH WAR. 1745. Reverse. THESE BANNERS SPREAD, ARE GALLIA'S DREAD. Shield bearing St. George piercing the shield of France; supporters, the British lion and the Austrian eagle; crest, Britannia,

FIGURE 253.
Badge of the President of the Beefsteak Club, formerly the property of Sir Henry Irving, now in the collection of A. M. Broadley.

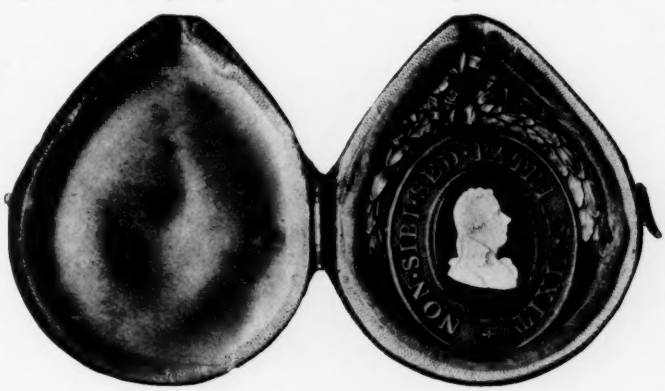

FIGURE 254.
Cameo Jewel of the London Pitt Club, in the collection of A. M. Broadley.

FIGURE 255.

The very rare silver gilt Badge of the Beggar's Benison Club at Anstruther, Scotland. In the collection of A. M. Broadley.

two flags at either side; motto, FOR OUR COUNTRY.

The reverse of this medal is beautifully reproduced in enamel in the centre of the elaborate badge, surrounded with fine paste ornaments,—now in my collection. This was probably worn by the President of the Loyal Association, who may have belonged to the fair sex.

In 1789, after the famous battle of the Regency, a medal was struck both in pewter and gilt bronze in honour of William Pitt, bearing on the reverse the words: "May Britain still flourish under our good King and his virtuous Minister." Another medal of that momentous year shewed the head of Pitt, the Premier, on one side and that of Thurlow, the Chancellor, on the other. From 1789 onwards Pitt was the object of many medallic honours, but it was not till after his death at the beginning of 1806 that innumerable Pitt Clubs came into existence with a view to perpetuate at once the policy, the patriotism and the memory of the "Pilot who weathered the storm." Of these loyal associations the London Pitt Club is probably the sole survivor, for the non-political Cambridge Pitt Club was founded at a later date, and for a different purpose. Nearly every Pitt Club had its own distinctive badge, some of them being now extremely rare, but in one or two instances a Pitt commemorative medal was used, with a special border and suspensory loop added to it. The silver gilt and cameo badge of the parent Pitt Club, that of London, is now reproduced (see Figure 254). The original cameo, from which the others were copied, is, I believe, now in possession of Dr. Fletcher, the President and Treasurer of the Cambridge Pitt Club. It was cut about 1790 by James Tassie, a British modeller (1735-1799), a full account of whose work will be found in the issue of the *Numismatic Circular* of May, 1912. The provincial Pitt Club badges in my possession are those of Liverpool (Wyon, Junr.) 1814, Nottingham (Webb) 1814, Manchester (Wyon) 1813, Stirling 1814, Warrington 1814, Birmingham 1814, Wolverhampton (Wyon) 1813, Leicester Town and Country (Webb) no date, Blackburn (Halliday) 1814, Rochdale (Webb), 1813 and Sheffield 1810. They are all in silver. The finest of them is that of Rochdale, which has on the obverse a profile portrait of Pitt, with the words "Gulielmo Pitt. R. P. Q. B." On the reverse is a storm-beaten rock and the legend *Patriae columen decus.* The majority of the Pitt medals have the motto *Non sibi sed patriae vixit.*

FIGURE 256.

Gilt and enamel badge given by George III to his physicians after his recovery from his mental affliction in 1789. In the collection of A. M. Broadley.

Most of the eighteenth-century clubs (and their name was legion) had their distinctive badge. The Beefsteak Club certainly dated from that period, but on the reverse of the large and handsome silver gilt badge (once the property of Sir Henry Irving) now reproduced, are the following words:—"15 Nov: 1803. Founders Sir John Turner,

FIGURE 257.

Silver Masonic Medal or Badge given by William, Duke of Cumberland, to Ralph Allen of Bath, in 1752. In the collection of A. M. Broadley.

E. Foulkes, R. Ramsbottom, I. Nixon" (see Figure 253). Any explanation of this inscription would be welcomed by me. On the obverse is engraved the motto *Esto perpetua ad libitum*. At the establishment of Mr. A. H. Baldwin in Duncannon Street the writer recently saw the badge of the "Leg of Mutton" Club — a *gigot au naturel* neatly chased in solid silver. The rare badge of the Beggars' Benison Club (see Figure 255) which was obtained for the writer by Mr. Baldwin, is characteristic of the eighteenth century, to which it belongs. On the obverse are depicted Adam and Eve, naked, standing facing, their hands joined; Adam

FIGURE 258.
Masonic Badge given to Edmund Kean by J. Latrobe Wright of Waterford, formerly owned by Sir H. Irving, and now in the collection of A. M. Broadley.

FIGURE 259.
Silver pass to Drury Lane Theatre given by David Garrick to his physician, Dr. Schomberg (1770). In the collection of A. M. Broadley.

points to a bower; at their feet a lion. Legend: "Be fruitful and multiply." On the reverse is Venus, recumbent, beneath a canopy; at her side Cupid; behind, Adonis with a spear, and a dog under a tree. Legend: "Lose no opportunity." This medal has a loop for suspension, and the example given shews a piece of the original ribbon. "The Beggars' Benison" was instituted at Anstruther about 1739, ostensibly as an association for the collection of "good" songs, stories, jokes, and *facetiae* of all kinds, but in reality to serve as an outlet for the most exuberant and outrageous fun and jocularity of the roughest description. It included eminent men of all classes, besides many noblemen, and even some members of the Royal Family. Each member upon his institution paid an entrance fee of ten guineas and received an elaborately-illuminated diploma, as well as the badge of the order. This club came to an end about 1830. The badge given by

FIGURE 260.
Pass to the Prince Regent's box at the King's Theatre, Haymarket (1814). In the collection of A. M. Broadley.

George III to his medical attendants after his recovery in 1789 is very scarce (see Figure 256), but needs no special description. Later in this year many medals and tokens were struck to commemorate the visit of the King and Royal Family both to Weymouth and Plymouth. Books might very well be written both on the Pitt Club badges and those which form part of the insignia of Freemasonry.

The Grand Lodge of Freemasons originated in 1717, and enormous prices are given for medals and badges connected with the early portion of the

FIGURE 261.
Silver box pass of Smock Alley Theatre, Dublin. In the possession of Messrs. Maggs.

history of that powerful social and philanthropic society. Badges were also used by the members of other associations formed in imitation of the Freemasons, like the "Bucks," the "Sols," the "Gregorians" and many others. Colonel Sir W. Watts, K.C.B., has succeeded in obtaining specimens of the badges worn both by the "Bucks" and "Sols." A very rare and curious medal of a Masonic character (certainly intended to be worn) is in the possession of the writer. It was thus described in the Buick Sale, of November 27th–29th, 1907, at Sotheby's:—"A large engraved badge (see Figure 257); on one side is engraved the Royal Arms, and the legend—

The gift of His Royal Highness W.D. of Cumberland To the Famous Mr. Allen 4 Dec 1752.

The reverse has a number of Masonic emblems and the name of *John Campbell* of Armagh." After seeing an illustration of it, the late Mr. W. J. Hughan wrote to me that he regarded the badge "as one of the most curious and valuable in existence." I have already dealt in detail with the history and associations of the Ralph Allen medal in the pages of *The Numismatic Circular*, *Somerset and Dorset Notes and Queries*, and the *Transactions of the Dorset Masters Lodge, No. 3366*. It is not absolutely certain that Duke William was a member of the Masonic Order, but there are grounds for believing that he belonged to it. The inscription on the reverse is certainly posterior to that on the obverse by at least eleven years, and the late Mr. Hughan was of opinion that the emblems themselves are of the 1752 period if not earlier. The late Mr. Sadler said the postdating of Mason medals is of frequent occurrence, and several examples of it occur in the collection which owes so much to his knowledge and enthusiasm. Possibly Ralph Allen, not being a Freemason, may have given the medal to John Campbell, who belonged to the Craft, for the genial owner of Prior Park lived quite six months after the formation of the lodge at Armagh. It may be that the relic came to him through Allen's heir, and that the second inscription is older than 1763 or 1764. The only one of the numerous John Campbells in the D. N. B. whose dates coincide with it on the medal, is a gallant sailor who went round the world with Anson. Admiral Campbell was born in 1720 and died in 1790.

The learned Dorset editor of the *Somerset and Dorset Notes and Queries* added the following note to my original remarks on the Cumberland-Allen Medal, with my entire acquiescence:—

"I believe that this interesting badge was not, at first, of a Masonic character, but a simple *pignus amoris* from the Duke of Cumberland to his friend. I take it that when it came, by gift or purchase, into the hands of John Campbell, the reverse, hitherto blank, was engraved with the present Masonic design, and the two small Masonic emblems inserted on the obverse. The engraving of these two emblems, and of those on the reverse, suggest the hand of an inferior workman, and the crookedness of one of the pillars, the want of correctness in the curve of the surrounding oval, the irregularity of the lettering, and the poverty of the mantling on the reverse, so different from the fine work of the mantling above the Royal Arms, seem to indicate additions by a less skilled or a provincial engraver, who may have copied an old model, or whose want of skill has imparted an antiquated character to his work."

Edmund Kean, quite early in life, became a Freemason, and it was the "brethren of the Mystic Tie" in Dorchester who helped him on his road to Drury Lane and celebrity, when the chance of a lifetime came to him on January 26th, 1814. From the collection of the late Sir H. Irving (also a Freemason) came the fine and curious badge given to Kean by Mr. J. Latrobe Wright, of Lodge No. 230, Waterford. (See Figure 258).

Admission tickets to theatres, masquerades, concerts and other entertainments are sufficiently abundant. They are generally of metal, but are occasionally engraved on bone or ivory. The unique badge-ticket to Drury Lane (for it has a loop for suspension) which David Garrick gave to his medical attendant, Dr. Isaac Schomberg, is extremely interesting. (See Figure 259). A full-length figure of Shakespeare appears on the silver pass to the Smock Alley Theatre, Dublin, now in possession of Messrs. Maggs, of 109, Strand. It is thus described by the present owners:—"A very rare silver pass engraved with full-length portrait of Shakespeare shewn leaning on pedestal; on the reverse, inscription along top '*Theatre in Smock Alley*,' and underneath '*The Rt. Honble. the Countess of Branden.*' The Pass is circular in shape and measures about four-and-a-half inches in circumference. Preserved in a neat leather case." (See figure 261).

In the fine collection of the late Mr. Montague Guest were several metal passes to Vauxhall and Ranelagh Gardens. The writer possesses similar admission-passes to both the historic theatres in the Haymarket. They vary from the humble copper pit order, which enabled the possessor to enjoy the drollery of Samuel Foote, to the gold and silver medals given to the box-holders of the Italian Opera across the way. The elaborate silver-gilt badge now reproduced was presumably an open sesame to the King's Theatre box of the Prince Regent between 1812 and 1820. Its weight must have proved somewhat trying to the wearer. (See Figure 260).

NOTES.

ASTRONOMY.

By A. C. D. Crommelin, B.A., D.Sc., F.R.A.S.

THE ECLIPSE OF THE SUN, APRIL 17TH.—Fine weather favoured this phenomenon all along the central line, and the spectacle was enjoyed by a large number of visitors from this country. It was known in advance that only the most fleeting glimpse of the corona could be expected; this was obtained by a few, including Professor Turner. In Portugal, Mr. Worthington saw it for several seconds, and was able to note that it was of the "wind-vane" type associated with spot-minimum. Mr. Slater succeeded in photographing it.

The duration of totality in Portugal given by *The Nautical Almanac* (half a second) was verified, thus showing that the diameter of the Moon used for eclipses is correct. As regards the position of the central line, the American Ephemeris is to be congratulated on its successful prediction. It applied $+9''\cdot8$, $+1''\cdot7$ to the calculated longitude and latitude of the Moon, the result showing that these corrections were very nearly right, but probably that in longitude should be slightly increased, and that in latitude diminished. Our *Nautical Almanac* and the German one did not attempt to correct the Moon's place, and their tracks were two or three miles too far to the N.W.; the French one corrected the Moon's R.A. but not her Dec., and its track was a mile and a half too far S.E.

The eclipse near Paris was neither total nor annular, though many observers erroneously used the latter term. An *annulus* means an unbroken ring. I observed by projection on a white screen, thus reducing irradiation, and I can say with confidence that there was not a continuous ring of sunlight, but only disconnected patches in the depressed parts of the Moon's limb. Baily's Beads were beautifully seen.

The light at mid-eclipse grew quite dim, and of a weird reddish or purplish tinge. M. Antoniadi ascribed this to the fact that we were only receiving light from the extreme edge of the Sun, which has to traverse a great extent of solar atmosphere, most of the blue light being absorbed.

M. and Mme. Antoniadi made interesting observations of the shadow bands, which they describe as wriggling snakes moving rapidly in the direction of their own length in a direction nearly away from the Sun, *i.e.*, from S.S.W. to N.N.E. (this was also the direction of the wind) at a speed about equal to that of a running man. In most eclipses the motion of the bands has been transverse to their length.

THE INTERESTING MINOR PLANET M.T. — The discovery and loss last October of this interesting body will be remembered. It was discovered by Dr. Palisa at Vienna, and was remarkable for the fact that, although in opposition, it was *advancing* pretty rapidly in R.A. Hence its orbit is evidently highly eccentric. There is not really enough observational material to determine the orbit, the following four positions being all that are available; the first two were made by Palisa at Vienna, the others by Pechule at Copenhagen:—

	Local M.T. 1911.	Apparent. R.A.	Apparent. Dec.
Oct.	$3^d\ 14^h\ 51^m\ 56^s\cdot0$	$0^h\ 42^m\ 4^s\cdot83$	N.0° 15′ 40″·8
,,	4 10 49 41·3	0 43 43·30	S.0 12 48·9
,,	4 14 11 3·0	0 43 58·99	S.0 17 50·8
,,	4 15 7 5·0	0 44 3·14	S.0 19 12·5

With this material two independent determinations of the orbit have been made; the first by E. S. Haynes and J. H. Pitman in *Lick Bulletin*, No. 210, the second by Dr. Franz in *Astr. Nachr.*, 4571. The first seems entitled to rather more confidence from the more reasonable values of the eccentricity and period: there is one point in favour of Franz's orbit, *viz.*, it makes the diminution of brightness more rapid, which would explain the failure to recover the planet towards the end of October. It will be seen that the node, inclination, time of perihelion, and perihelion distance are known within fairly narrow limits, but that the eccentricity and period are subject to great uncertainty. Both the orbits are referred to the ecliptic and equinox of 1911·0.

	Lick Orbit.	Franz Orbit.
T ...	...1911 Aug. 20·748 G.M.T.	Aug. 15·097 G.M.T.
ω ...	...141° 20′ 27″	127° 37′ 39″
☊ ...	...185 35 59	185 54 27
ι ...	... 9 31 23	11 28 42
ε ...	...0·50937	0·8153
μ ...	...1050″·1	283″·8
a ...	...2·2518	5·387
Period	...3·379 years	12·50 years
q. ...	...1·1048	0·995
Aphn. dist.	...3·3988	9·779

Both orbits make the brightness a maximum a month before discovery, when it was probably of the tenth magnitude, and being in high north declination there is still a chance that some further images may be found on photographs in September or October. The ephemeris from the Lick orbit is given to illustrate the curious motion of such an eccentric body when near the earth. It is for Greenwich midnight.

1911.	R.A.	Dec.	Dist. from Earth	Mag.
Sept. 1	$22^h\ 15^m\cdot8$ ...	31° 3′ N ...	·1318 ...	10·7
,, 9	23 11 ·1 ...	22 45 ...	·1359 ...	
,, 17	23 53 ·2 ...	13 44 ...	·1515 ...	11·1
,, 25	0 22 ·4 ...	6 0 ...	·1779 ...	
Oct. 3	0 42 ·0 ...	0 19 N ...	·2140 ...	12·0
,, 11	0 55 ·2 ...	3 29 S ...	·2585 ...	
,, 19	1 4 ·6 ...	5 47 ...	·3112 ...	12·9
,, 27	1 12 ·0 ...	6 56 ...	·3718 ...	
Nov. 4	1 18 ·7 ...	7 15 ...	·4403 ...	13·8
,, 12	1 25··2 ...	6 58 ...	·5167 ...	
,, 20	1 32 ·0 ...	6 15 S ...	·6010 ...	14·6

With the aid of this ephemeris, images of the planet have just been found on three plates taken at Greenwich on October 11th. These will enable a more reliable orbit to be calculated: there has not been time to do this yet. The observed R.A. is 32 sec. greater than the ephemeris, the observed Dec. 11′ 25″ south. It would seem that the eccentricity is smaller even than the Lick value.

ROTATION OF URANUS.—The extreme difficulty of ascertaining the period of rotation of Uranus by direct observation of the disc is well known, as spots are rarely seen, and when seen they are usually of a belt character, giving no definite point to select. In the March number I described Professor Bergstrand's attempt to determine it by the motion of the peri-uranium of the nearest satellite, Ariel. He gave the rather wide range of 11·3 to 17·6 hours, thinking thirteen hours the most probable.

At the May meeting of the Royal Astronomical Society, Professor P. Lowell exhibited and described a beautiful series of photographs of the spectrum of Uranus, taken by Mr. Slipher at the Flagstaff Observatory. It is only in the last few years that the position of Uranus has made the application of the method possible, as before that its pole (assumed to be coincident with the pole of the orbit-plane of the satellites) had been for several years nearly central in the disc, so that there was no rotational movement in the line of sight. The slit was placed in the direction that would produce the maximum inclination of the spectral lines as compared with those of the comparison spectrum, and the inclination obtained is quite obvious to the eye, and fully ten times the estimated probable error of a determination of inclination for one line. Several lines were measured, and the result deduced that Uranus rotates in a retrograde direction in a period of ten and three-quarter hours. This is quite a reasonable result, being near Bergstrand's lower limit, and we may take it as by far the most reliable value yet obtained. See's estimate of $10^h\ 7^m$ was in tolerable accordance with it. We may hope that the spectroscopic method will be applied to Neptune also.

XUM

BOTANY.

By PROFESSOR F. CAVERS, D.Sc., F.L.S.

THE SOIL AND THE PLANT.—Under this title, Dr. Russell has recently (*Science Progress*, No. 21, 1911) discussed various problems raised by the researches of the past few years into the relations between plants and the soil. He points out that both the chemical and physical properties of the soil affect the growth and health of the plant; also that it is most improbable, as suggested by some recent workers, that the chemical properties of the soil are relatively insignificant in determining fertility. A deficiency in any one factor limits the effectiveness of the rest, and many of the injurious or inhibiting factors are profoundly influenced by the presence or absence of calcium carbonate in the soil. He criticises the various theories brought forward by the members of the United States Bureau of Soils, regarding the concentration of the soil solution, its constancy of composition, the toxic nature of certain soil water for plant growth, and the part played by fertilisers. As to toxic or poisonous substances, it cannot be taken as proved that a substance toxic in water culture is necessarily toxic in the soil itself, as the soil possesses absorptive properties. Moreover, no evidence of the existence of poisonous plant-excretions in the soil has yet been obtained, and the continuous growth of wheat on one field at Rothamsted for nearly seventy years is cited as a proof to the contrary.

In this review, it is clearly shown how complex is the relationship between the soil and the plant, and how important a part is played by the biological factors, as well as the chemical and physical constitution of the soil, in determining the total effect upon plant growth. A list of the recent literature on the subject is appended to the paper.

BRITISH ELMS.—The Elms which occur native or naturalised in this country are often difficult to determine, owing to variation in the size and hairiness of the leaves, the presence or absence of suberosity, and the occurrence of hybrids. Dr. Moss has contributed to *The Gardeners' Chronicle* a series of articles (*G. C.*, Nos. 3718–3720) on the British Elms, in which most of this confusion has been cleared up. The various species and hybrids are critically described and discussed, and a new variety is indicated. The author points out, in dealing with the question of hybrid Elms, that the early interpretation of the occurrence of such forms—that plants yielding mixed seedlings were not good species—has had a good deal to do with the reduction by many botanists of British Elms to two or even to one species. This view is discredited by the recent results of experiments which show that a "pure line" may yield seeds producing mixed seedlings if pollinated either by another "pure line" or by a hybrid; hence it is now necessary, before it can be said that a plant of unknown origin is a hybrid, to self-pollinate the plants and use only the seeds obtained by this means. If such seeds yield mixed seedlings, it may be regarded as established that the plant which produced them is a hybrid. Even then, however, there is no proof of the parentage of the hybrid. To obtain such proof, it is necessary to produce the hybrid in question by cross-pollinating known plants, and apparently this has not yet been done in the case of Elms.

The formation of an excess of corky tissue is to be regarded as an abnormality which may occur in any of our Elms, except the Wych Elm (*Ulmus glabra*). Such names as "*Ulmus suberosa*" or "*Ulmus campestris* var. *suberosa*," if founded on the presence of suberous bark alone, are to be rejected. The occurrence of suberosity is common in some cases (*e.g.*, the Dutch Elm) and rare in others (*e.g.*, the Huntingdon Elm). The suberosity is commonest on the young branches produced from adventitious buds low down on the trunk and on suckers. Its cause is a matter for investigation by the plant pathologist rather than the systematist, but it is interesting to note that all our Elms which produce suberous bark also have suckers.

Another cause of confusion is the smoothness or roughness of the upper surface of the leaves. In the Wych Elm and English Elm all the leaves are rough above, but the remaining Elms are usually described as having the leaves smooth above. This, however, only applies to leaves produced in Spring on young branchlets of the main branches (called "normal leaves" in the Key). It does not apply to leaves formed on suckers, or on twigs produced from adventitious buds low down on the trunk, or on coppiced or cropped shoots, or on seedlings, or even on the new shoots produced in summer on the main branches—all these leaves are invariably rough above. This, the author believes, has never been pointed out before; and in assessing the value of old descriptions it is sometimes necessary to reject all references to the smoothness or hairiness of Elm leaves.

The *size* of Elm leaves has also led to confusion, through not allowing for the variability in each species, variety, or hybrid. On every shoot, of course, the size of Elm leaves varies considerably; and in the Key the descriptions of the leaves refer only to the terminal leaves of each branch, unless otherwise stated. By allowing for some variation, it is possible to identify any British Elm by its normal leaves alone.

As the present writer has frequently had specimens of Elms sent to him for identification by readers of "KNOWLEDGE" and other students of our British trees, it may be useful to reproduce here the key given by Dr. Moss at the conclusion of his articles on the British Elms. Permission to do this has been kindly granted by Dr. Moss and by the Editor of *The Gardeners' Chronicle*. In the Key, an asterisk (*) indicates that the tree is not indigenous in the British Isles, a dagger (†) that it is doubtfully indigenous. The Wych Elm (*U. glabra*) is indigenous throughout Britain; *U. nitens* and *U. sativa* are indigenous in south-eastern England and in the Eastern Midlands (*U. sativa* is also possibly indigenous in Hampshire and Glamorganshire); the Dutch Elm seems to be indigenous in Cambridgeshire and no doubt elsewhere.

I.

Tree without suckers and without suberous bark; branches usually more or less arched; crown of tree large; stamens usually five or six, rarely four or seven; samara large (about one inch long), seed in the centre; laminæ always rough above and acuminate, of the terminal leaves large (about five inches long and nearly three broad), almost sessile.—WYCH ELM (*U. glabra* Hudson).

Tree with suckers; bark suberous or not; stamens usually four; seed usually between centre of samara and the notch.—II.

II.

Tree very tall at maturity; bole long, straight; lower branches§ wide-spreading; crown large; samara small (about half an inch long), suborbicular; laminae always hairy or rough above, of the terminal leaves rather large (about three and a half inches long and two inches broad) and acute-acuminate, of the remaining leaves of each branchlet shorter, suborbicular; petioles about one-third of a inch long, hairy.—†ENGLISH ELM (*U. campestris* L.)

Normal leaves smooth or glabrous above.—III.

III.

Samarae and laminae of the terminal leaves as broad as or nearly as broad as those of the Wych Elm; position of seed variable.—IV (Hybrid Elms).

Samarae and laminae of the terminal leaves much narrower than in the Wych Elm; seed between centre of samara and the notch.—V.

IV.

Bole usually short; lower branches widespreading and usually very long; crown very large; laminae acute, of the terminal leaves about four inches long; petioles nearly a half inch long, hairy.—DUTCH ELM (*U. glabra* × *nitens*—(a) × *U. hollandica*).

§ The lower branches of hedgerow trees are usually lopped; and thus the typical habit is destroyed. In some districts, *e.g.*, in Brittany, the branches are lopped almost from foot to crown; and then the precise determination of the tree is a matter of difficulty.

Bole usually short; all the main branches of young trees ascending at a very acute angle; crown very large; laminae acute-acuminate, of the terminal leaves about five inches long; petioles about a half inch long, usually hairy.—*HUNTINGTON ELM (*U. glabra* × *nitens*—(b) × *U. vegeta.*)

V.

Tree tall at maturity; bole long, straight; lower branches wide-spreading; crown rather large; samara small, rather less than half inch broad, obovate; laminae acute or acuminate, very smooth and shiny above, of the terminal leaves about three and a half to four and a half inches long and about two inches broad; petiole about a half inch long, glabrous at maturity.—SMOOTH-LEAVED ELM (*U. nitens* Moench).

Tree small; laminae of the terminal leaves short, less than two and three-quarters inches long.—VI.

VI.

Tree not pyramidal; lower branches wide-spreading; crown usually small, sometimes rather large when the upper branches of old trees are very tortuous; winter buds usually smaller than in any other Elm; this and *U. stricta* are the last Elms to come into flower; samara small, narrower than in any other British Elm, being only about three-tenths of an inch wide, oblong-elliptical; laminae acute or sub-obtuse, never acuminate, of the terminal leaves about two to two and three-quarters inches long or even shorter, and about one and a quarter to one and a half inches broad; petiole about two-fifths of an inch long, usually rather hairy and rough.—SMALL-LEAVED ELM (*U. sativa* Miller.)

Tree pyramidal; branches fastigiate or sub-fastigiate.—VII.

VII.

Branches fastigiate; samarae about a half inch wide, slightly obovate; laminae about as broad as in *U. sativa*, each half bent inwards or upwards on the midrib (when fresh), subcoriaceous; petiole as in *U sativa*.—† CORNISH ELM (*U. stricta* Lindley).

Branches subfastigiate; laminae flat, broader (about one five-eighths to one and three-quarters of an inch broad) than in *U. stricta*.—* JERSEY ELM (*U. stricta* var. *sarniensis* Moss).

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (OXON.), F.I.C.

SPONTANEOUS COMBUSTION OF CHARCOAL.—The Report of the National Physical Laboratory for 1911, which has recently been published, contains (on p. 86) an interesting account of the results of experiments made to ascertain the liability of charcoal to undergo spontaneous combustion.

In these experiments one cubic foot of the charcoal was exposed in an electrically-heated oven to temperatures which were kept constant within 1° C. by means of thermo-couples. An air-space of about three inches was provided all round the charcoal, and the observations were made both with the oven kept tightly closed and with charcoal exposed to air currents of regulated velocity. It was found that when flake charcoal was heated in currents of air varying from five to sixty-two cubic feet per minute, for one cubic foot of the charcoal, ignition occurred at temperatures of 96° to 110° C., but that at lower temperatures there were no indications of spontaneous heating.

Exposure of the charcoal to a current of air containing five per cent. of sulphur dioxide caused spontaneous ignition to take place in the course of a few hours. From these results the conclusion is drawn that disinfection of a room by means of sulphur dioxide may be attended with some risk of spontaneous combustion when the walls contain charcoal. There is much less chance, however, of decayed wood becoming ignited in this way, as it does not take fire so readily as charcoal.

ARSENIC IN VEGETABLE PRODUCTS.—Since it has been shown by MM. Gautier and Bertrand, that arsenic occurs normally in the tissues of man and of animals, various investigations have been made to discover the source of the arsenic. Experiments made by MM. Stein, Gautier and Claussmann have indicated that the arsenic probably originates chiefly from vegetable foods, and its presence has hitherto been detected in cabbages, potatoes, wheat and sorrel.

This conclusion now receives confirmation from the experiments of MM. Jadin and Astruc (*Comptes Rendus*, 1912, CLIV, 893), who have made a systematic examination of thirty-six different kinds of vegetable products, including fungi, fresh and dried vegetables, cereals, nuts, and fresh and dried fruits.

In each case the arsenic was estimated by a modification of Marsh's method, with all the usual precautions as to purity of reagents and so on, and the results were expressed in milligrammes per 100 grammes of material.

Arsenic was present in varying proportions in every instance. Thus, in the fresh vegetables it ranged from 0·004 milligramme in peas to 0·023 milligramme in lettuce, while the edible portion of fresh fruits yielded from 0·005 milligramme (chestnuts and apples) to 0·012 milligramme (mandarines). Mushrooms contained 0·006 milligramme and truffles 0·020 milligramme.

PURITY OF LONDON'S WATER SUPPLY.—The Seventh Annual Report (for 1911) of the Metropolitan Water Board gives further details of the researches of Mr. A. C. Houston upon the vitality of pathogenic micro-organisms in water. Various bacteria were added to samples of river water, and cultivations made to ascertain how long they survived. The results confirmed those previously recorded, and showed that typhoid bacilli did not survive more than three weeks under these conditions, their vitality being thus much lower than in the laboratory cultivations.

Other experiments upon the river water as received showed that it is exceptional for pathogenic micro-organisms to be found in small quantities of the water. Out of seven thousand nine hundred and ninety-one colonies examined, only one micro-organism resembling the typhoid bacillus was found.

From these results it would seem that storage of river water for a month is practically sufficient to destroy all typhoid bacilli.

Lowering the temperature had a curious effect in prolonging the life of typhoid bacilli added to river water, temperatures below 41° F. being much more favourable to their survival. Yet, even in the case of water chilled to the freezing point, only one typhoid bacillus was alive after a month.

A marked improvement in the chemical and bacteriological character of the river water was effected by a preliminary storage for a day in small reservoirs, prior to its being transferred into the main storage reservoirs. This improvement was still further enhanced by treating the water with a small proportion of an "alumino-ferric" coagulating agent, on its way through the small reservoir.

FERTILISING ACTION OF SULPHUR.—According to M. A. Demolon (*Comptes Rend.*, 1912, CLIV, 524) residues from the gas works are extensively used in the North of France as fertilisers for the soil. Analyses of various samples of the material showed that it contained about forty per cent. of sulphur, and from one to three per cent. of nitrogen in the form of ammonia or its salts.

The value of the substance as manure was found to depend upon the sulphur, and this conclusion was confirmed by practical tests in which flowers of sulphur were incorporated with garden soil. In every instance, the growth, both of the roots and the leaves, was promoted, and the colour of the plants was a deeper green. Apparently, the sulphur acts by stimulating the formation of chlorophyll. A portion of it becomes oxidised to sulphate in the soil.

GEOLOGY.

By G. W. TYRRELL, A.R.C.Sc., F.G.S.

AUSTRALIAN GLACIATIONS.—W. Howchin writes on this subject in *The Journal of Geology*, April-May, 1912. Australia has experienced three well-defined periods of glaciation in the Cambrian, Permo-Carboniferous and Pleistocene.

XUM

In each case the distinctive evidences of ice-action are unmistakeable and widespread. So clear and typical are they in the remoter periods that it is difficult to realise their antiquity.

The Cambrian glacial deposits are best developed in South Australia. They form portions of a non-fossiliferous series underlying a very thick formation containing numerous limestones crowded with the typical Cambrian fossils. The glacial beds have a lateral extent of two hundred miles, and consist mostly of boulder-clay or till, with stones reaching nine feet in diameter. The included stones are erratics, granites, gneisses, and so on, which cannot be matched anywhere within the limits of South Australia. Photographs of glaciated stones and an exposure of till shew that the material is identical with that of recent glacial deposits. Great earth-pressure, which has been sufficient to produce cleavage in the mudstone base, has not availed to destroy the scratches and facetting of the included stones.

The most important glaciation of Australia, alike in its variety of features, wide distribution and stratigraphical development is that of the Permo-Carboniferous. Each of the Australian States and Tasmania have representatives of these deposits. In addition to the features already enumerated in the Cambrian, this glaciation also shews smoothed and striated glacial floors and roche moutonnée outlines now exposed by denudation. The Cambrian till is interbedded with true marine deposits and is regarded as having been deposited by floating ice. The Permo-Carboniferous, however, must have been land ice, as is shewn by the absence of contemporaneous marine deposits, by striated pavements, and roches moutonnées. The general direction of ice-movement was from south to north, and the centre of distribution must have been well to the south of the present continent.

The Pleistocene glaciation was relatively small and was restricted to the south-eastern highlands of the present continent and the greatest altitudes in Tasmania. It presents most of the usual features and it is unnecessary to describe it here.

Striking photographs of the products of the ancient glaciations and a full bibliography are given with this important paper.

HUMAN SKELETON IN GLACIAL DEPOSITS AT IPSWICH.—The need for caution in dealing with human remains found in recent deposits is exemplified by two very interesting notes by G. Slater, F.G.S., and Professor T. McKenny Hughes in the April number of *The Geological Magazine*, on the discovery of a human skeleton in glacial deposits at Ipswich.

The pit in which the bones were found shews a considerable thickness of sand and gravel, covered by a bed of weathered clay four feet thick, including the soil-cap, and only two feet thick in the trench where the bones were discovered. Both Mr. Whittaker and Dr. Marr, who examined the section after the bones had been removed, identify the material as weathered and decalcified chalky boulder clay. The skull is filled with the same material, and it is thus evident that at the time the skull came into position the clay was in a very moist and waterlogged condition. Dr. Marr thinks it possible that the clay may have flowed from a higher level as a result of being water-logged, but does not undertake to distinguish a thin mass of such slipped material from true, undisturbed boulder clay. According to Mr. Slater there is a slope of fifty feet in half a mile on the plateau to the east of the pit, and he thinks it reasonable to suppose that at least the upper part of the clay in the section is due to rainwash. The bones were found partly in the clay and partly in the underlying sand, and it is difficult to understand how this could have occurred naturally, considering the different modes of deposition of the clay and sand. According to Mr. Slater all the evidence points to the probability that the man was buried in a narrow and shallow grave, but there is no way of arriving at a determination of the age of the interment.

Stress has been laid on the point that no indication of a grave could be seen in the section. Professor McKenny Hughes has an interesting letter on this subject in the same issue of *The Geological Magazine*. He instances the case of a Roman and Saxon cemetery exposed at Faversham. In ordinary dry states of the weather no sign of disturbance could be detected in the section that would indicate an interment. The graves were dug in homogeneous brick-earth, with no lines of stratification or bands of pebbles to be broken across, and thus betray disturbance. In wet weather, however, a slight darkening of the moved soil in the graves could be detected.

In the case of a skeleton recently discovered at Barrington by Professor Hughes, as also at Ipswich, no signs of disturbance were noted in the enclosing earth, but in view of the above facts, no importance can be attached to the absence of such signs. Professor Hughes thinks that the clay above the Ipswich skeleton was merely "soil" or "head," and not true boulder-clay at all.

In a letter to the May *Geological Magazine*, Mr. Reid Moir, the discoverer of the Ipswich skeleton, admits the importance of Professor Hughes' observations on the obliteration of all signs of interment in a homogeneous material. He points out, however, that Mr. Slater has apparently changed his opinions, for in a report signed by Mr. Slater and dated October 21st, 1911, there occurs a statement to the effect that the pit in which the bones were found shewed a clear and undisturbed section of weathered boulder-clay, over the calcareous sands in which the remains were partly embedded. He also corrects the statement of the gradient of the plateau to the east of the site, reducing it to twenty-six feet in the half-mile.

METEOROLOGY.

By JOHN A. CURTIS, F.R.MET.SOC.

The weather of the week ended April 13th, as set out in the weekly weather report issued by the Meteorological Office, was at first unsettled, with showers in all districts, and a good deal of snow or sleet in the North. The latter part of the week was generally fine. Temperature was below the average in all districts except Ireland S., and the English Channel, where it was very slightly above the normal. The differences, however, were very slight except in Scotland, N. and E. The highest readings reported were 63° at Oxford and Hereford, on the 7th; with 62° in several places. In Scotland, N., the maximum was only 54°, and in the English Channel 57° was the highest reading reported.

The lowest readings were 20° at Balmoral and West Linton on the 12th, but readings of 26° or less were observed in all districts except in Ireland, where the minimum was 31°, and in the English Channel where it was 40°.

On the grass low readings were reported at many stations, the lowest being 14° at Birmingham and Newton Rigg. At depths of one foot and four feet, however, the temperature was still above the average.

Rainfall was less than usual very generally, but in Scotland E. it was slightly in excess of the normal, while in Scotland, N. it was three times as much as usual. At Glencarron nearly four inches of rain was collected during the week, while at Tottenham and Dungeness the week was rainless.

Sunshine was in excess in Eastern districts, by nearly two hours a day in many places, but in Scotland, N., and in Ireland it was in defect. At Westminster the daily average duration was 5·7 hours (43%). At Yarmouth it was 8·1 hours or 60% per cent.

The sea water was warmer than usual, the means ranging from 42°·1 at Berwick, to 50°·5 at Scilly and Salcombe.

The week ended April 20th was dry and bright generally, but some heavy falls of rain were reported in Ireland on the 20th. A thunderstorm was experienced in Canterbury on the 18th. Temperature had risen considerably, and was above the average in all parts, very considerably so in Scotland. The highest readings reported were 71° at Raunds, and 70° at Lincoln, Hillington, Bawtry and Oxford. Frost was, however, experienced at many stations, the lowest readings being 27° at Marlborough and Llangammarch Wells. In Scotland, N., the lowest reading was 35°, and in Ireland 34°. In the English Channel the temperature did not fall below 41°. On the grass low readings were again reported, the lowest being 20° at

Birmingham and 21° at Ranceby and Wisley. The earth temperature was only slightly above the normal.

The week was very dry, the rainfall being less than the average in all districts except Ireland, S., where it was 0·07 inch in excess. In Scotland, E., the Midland Counties, and England, E., and N.W., no rain was reported at any station throughout the week, and in all parts except in Ireland the amounts collected were very small.

Sunshine, on the other hand, was in excess in all districts except Ireland, N. In Jersey the amount registered amounted to a daily average of 10·7 hours or 78 per cent. of its possible duration.

In Westminster the value was 6·3 hours per day, 45 per cent., while at Brighton it was 9·0 hours (65%).

The sea temperature varied from 42° at Berwick to 55° at Ballintrae.

The weather of the week ended April 27th continued very fine as a whole, although some rain fell in Ireland and Scotland early in the week, and thunderstorms were reported from Ireland towards the end of the period. Temperature was still above the average in all districts, and as a rule to a considerable extent. Readings of 70° or upwards were reported in all the districts except Ireland, N., the highest readings being 72° at at Tottenham and Bawtry. Readings below freezing point were observed in two districts only, Scotland, E., and England, S.E., the minima being 29° at Balmoral and West Linton, and 30° at Marlborough. The temperature at depths of one foot and four feet below the surface was again above the average.

Rainfall was extremely slight. In England, E., and the Midland Counties the week was rainless at each station for the second week in succession.

In England S.W., also, no rain was reported. In all the districts there were some stations at which no rain fell during the week.

Bright sunshine was in excess in all districts without exception. In six of the districts the daily average exceeded 10 hours the maximum value being 11·3 hours in England, S.E., or 79 per cent. of the possible duration.

The South Coast of England was extraordinarily sunny and while Worthing, Ventnor and Bournemouth each reported a daily average of 12·0 hours (85%), Portsmouth had 12·1 hours (86%) and Hastings 12·3 hours (87%). At Westminster the daily average was 10·8 hours (76%).

The temperature of the sea water round the coasts was still above the normal, the mean values ranging from 43°·4 at Berwick to 53°·2 at Plymouth.

The weather of the week ended May 4th was dry at first, but towards the end of the week welcome showers were experienced in most districts. Temperature was not far from the normal except in Ireland and the English Channel where it was somewhat in excess. The highest readings reported during the week were 70° at Tottenham and 69° at Marchmont, on May 2nd. The minimum were below the freezing point in every district except the English Channel. The lowest readings were 24° at Llangammarch Wells, and 26° at Marlborough on the 30th April. On the grass the lowest readings were 16° at Newton Rigg and 17° at Wisley. The temperature of the soil at one foot and at four feet continued above the average in all districts.

Rainfall was less than the average in all districts, and at Durham, Tunbridge Wells and Ventnor the week was rainless. In the English Channel the value for the week was only 0·05 inches, as compared with an average over twenty-five years of 0·45 inches, or one-ninth of the usual amount.

Bright sunshine was in defect as a rule, but in Scotland, N. it was more than the average by 0·3 hours a day, and in Scotland, W. it was normal. The sunniest district was the English Channel with a daily average of 7·5 hours (52%). In Scotland, E. and the Midland Counties the average daily amount was only 3·5 hours. In Westminster the daily mean was 4·8 hours (33%).

The sea temperature was again higher than usual, and the mean values ranged from 44°·0 at Berwick to 54°·8 at Scilly.

The week ended May 11th was very unusually warm, with light rainfall and scanty sunshine. Thunderstorms occurred on several days, and much fog was observed round our West and South coasts.

Temperature was above the average in all districts, the excess amounting to 9° in England, E., where maxima of 82° were observed on the 11th at Cromer, Norwich, Geldeston and Cambridge.

The highest reading reported was 83° at Greenwich, also on the 11th. Readings of 81° were recorded at Yarmouth, Raunds, and Camden Square. On the other hand, in Scotland, W., the maximum was only 64°. The lowest reading for the week was 31° at Strathpeffer, on the 5th, but at no other station was frost observed at four feet above the ground.

In more than half the districts no readings below 40° were reported, and in the English Channel the minimum was 47°. Sharp night frosts on the ground were observed, the lowest readings being 25° at Crathes and 27° at Birmingham. The temperature of the soil was still above the normal.

Rainfall was above the average in Scotland and in England, S.W., but was below elsewhere, except in the English Channel where it was normal. In Scotland, N., the amount was more than double the average and at Lerwick the total for the week exceeded two and a half inches.

Sunshine was deficient at every station except Aberdeen. In England, S.W., the mean value was 1·2 hours per day, or 5·6 hours below the average. At Aberdovey, Aberystwyth and Pembroke the duration was less than half an hour per day. At Westminster the mean for the week was 3·8 hours per day, or 25 per cent. of the possible duration. The sunniest station was Felixstowe with a daily average of 6·6 hours (44%).

The temperature of the sea water was still above the average, and the means ranged from 45°·2 at Berwick to 55°·2 at Plymouth.

RAINFALL OF APRIL.—The rainfall of April, 1912, was remarkable. In the West of Scotland the month was exceptionally wet, some places reporting totals of upwards of 10 inches. The East of Scotland on the other hand was very dry having less than one inch for the most part, less than half an inch round the coast south of Aberdeen, and less than 0·1 inch round the Firth of Tay. In Ireland the totals were not far from the average, but in England and Wales the month proved to be the driest April on record. At Camden Square Dr. H. R. Mill, of the British Rainfall Organization, recorded only 0·04 inches which was the lowest amount collected there in April since the record began in 1858. With one exception February, 1891, 0·01 inch, it was the lowest monthly total of that long series. Rainfall records are available at one or more London stations from 1781, and during this period of one hundred and thirty-two years only two Aprils (1817 and 1840) had less than 0·10 inch of rain, and these had 0·06 inches in each case.

Of twenty very dry Aprils it has been noted that in nineteen cases the following July was also very dry. It will be interesting to note if this sequence holds good in 1912, and if July this year is exceptionally dry in England and Wales.

During a kite ascent at Brighton, carried out under the direction of Mr. S. H. R. Salmon on May 11th, a remarkable rise of temperature with increase of height was observed. At the ground level the temperature of the air was 55°, but at a height of three thousand feet, instead of the usual fall of about 10°, there was a rise of 20° registered.

ECLIPSE OF THE SUN.—Observations taken at Greenwich during the Solar Eclipse on April 17th showed that the temperature of the air fell from 58°·2 at 10.55 a.m. to 52°·0 at 0.20 p.m., and rose again to 56°·7 at 1.45 p.m. The solar radiation as recorded by a black bulb thermometer fell from 104°·0 at 11.2 a.m. to 56°·8 at 0.20 p.m., and rose again to 101°·9 at 1.43 p.m.

MICROSCOPY.

By F.R.M.S.

INSECTS' EGGS have long been favourite low power objects with microscopists on account of their beautiful forms and delicate markings. Illustrations of a great many have been published in works devoted to entomology and microscopy,

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but those of the Phasmidae as figured by Kaup are so extraordinary as to give the impression that whoever originated the drawings must have drawn largely from his imagination, as surely no insect could lay an egg, the flat top of which is not only battlemented round the margin, but has a veritable cross more than one-fourth the height of the egg itself, standing erect and isolated in the middle of it.

Having recently received a number of the eggs of a species said to be *Dixippus morosus*, a microscopical examination of these may be of some interest. In colour they are a dark purple brown, the outer shell having a finely-granulated surface and being very hard and brittle; each egg also has upon one side only a curious cuneiform marking bordered with a dark chrome yellow band, this probably representing the point at which it was originally attached to the ovary. In shape they are somewhat elliptical measuring ·10-inch by ·07-inch, the upper end of each being slightly flattened and fitted with an oval cover ·05-inch by ·04-inch, on the top of which is a bright yellow knob, circular in shape with a diameter of

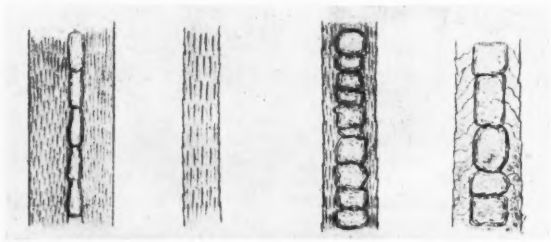

FIGURE 262.

A. Large coloured hair with small medullary cells.
B. A flat, coloured hair, strongly fibrous, with no medullary cells.
C. Coloured hair with large medullary cells.
D. Colourless hair with large medullary cells and sheathing cortical cells.

·02-inch and ·01-inch high, looking under the microscrope not unlike the lid of a brown earthenware teapot. The upper surface of the cover is formed of hard material uniform with the shell of the egg, but below this is a thicker layer of rather softer substance, darker in colour and finely toothed round the edge, the teeth fitting accurately into corresponding corrugations round the thickened edge of the opening, whilst below this again is a layer of stout white membrane similar to that with which the egg itself is lined. The knob has a deep depression in the centre, a section through which seems to show that at one time there was a perforation through this leading to the interior of the egg, probably in the nature of a micropyle. The use of the knob is not very obvious, as the larva when mature pushes off the cover from the inside, causing it to fall intact, but in escaping from the egg it frequently happens that the claws of one or both of the third pair of feet become so entangled in the lining membrane as to oblige the young insect to drag the empty egg shell about with it until artificially relieved. The larva when first hatched is so much larger than it seems possible for the egg to have contained that it is very probable the segments of which the body is composed may overlap each other before emergence, and the great increase in size after changing the skin is perhaps due to a similar cause. The eggs are laid separately, and are not attached in any way either to each other or to the place where they are deposited; the period at which they hatch out seems quite uncertain, as it takes place at all times of the year and is, apparently, not much affected by the temperature of the air; the young larva resembles the parent except as to size and the absence of wings. It has been said that these insects will occasionally devour those of their own species, but although this has not been conclusively proved against them, it may possibly account for the otherwise mysterious disappearance of sundry small specimens from a box in which others of various ages have been kept together.

R. T. L.

WHAT IS WOOL?—To many of your readers, no doubt, the query which I have used as the title of this note will cause some mild surprise. Textile fibres in immense variety, both of vegetable and animal origin, have been in use from time immemorial, and have been so thoroughly studied in every aspect, optical, chemical, physical and histological, that the mere suggestion as to there being any doubt as to the definition of *wool* will be to many unthinkable. There can be no doubt that wool, besides being one of the best known and most widely used fibres, was also one of the very first to be used by man to protect himself from the inclemency of the weather, following, indeed, very closely upon his first tentative, but unsatisfactory, essay in this direction. One's first thought is, very naturally, that *wool* is the hair of the sheep, as we are constantly reading of vast quantities of this commodity being imported from Australia, where sheep farming for the sake of the wool is the chief industry. This is, however, far from being the last word on the subject; for if we make the necessary enquiries we shall discover that commercially, at all events, the term *wool* is not solely confined to the product of the sheep. Hairs from several animals are described as being *wool*, no doubt from their having characteristics similar to those from the sheep. I need here only mention that the hairs of several species of goat, such as the Alpaca, Angora and Cashmere, are invariably designated *wool*; as are also the hairs of the llama and camel. Indeed, there can be little doubt but that many animals would furnish hairs which most microscopists would characterise as *wool*. Failing some authoritative decision on the point, it would appear that we can only fall back on the physical and microscopical characteristics of the fibre. In this connection it must not be forgotten that even the hairs of the sheep differ within fairly wide limits according to climatic and other conditions, the principal of which, no doubt, would be the breed of the sheep. Some of the larger and stouter show strongly marked medullary cells, with the overlapping cortical scales but weakly developed, while in the finer fibres there is an entire absence of the central, but the cortical cells are strongly developed. In what is recognised as the best wool from the sheep, a careful examination will show that the hairs have a soft, slender, wavy appearance, and microscopically the medullary, or central cells, are either absent or at least not strongly marked, while the cortical cells are well-

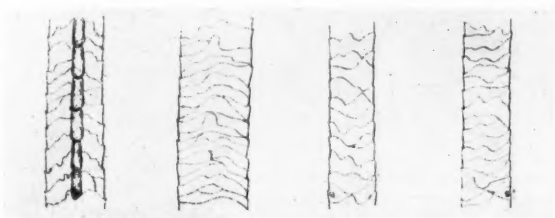

FIGURE 263.

E. Colourless hair with smaller medullary cells and well-marked cortical cells.
F. Large colourless hair with no central cells, but with fine and close cortical cells.
G. Fine hair with well-marked sheathing cortical cells.
H. Fine hair, similar to the last, but with finer cortical cells.

developed as sheathing scales, overlapping each other so as to give a finely-serrated appearance to the margin of the filament, and an appearance of fine, sinuous lines crossing the fibre. Any hairs having these characteristics would unhesitatingly be pronounced *wool* by most microscopists, and from a histological standpoint, they would be fully justified. There can, however, be little doubt that whenever the term wool is used in a commercial sense, without any qualification, the hair of the sheep is invariably meant. In an earlier part of this note, it was suggested that many animals on some parts of their bodies would furnish hairs with a very decided wool-like structure, which, if submitted to a microscopist,

would be designated *wool*. It is one of the commonplaces of knowledge, that the hairs of most, and probably all, animals differ very materially, according to the part of the body from which they are taken; those from the back, for instance, being usually coarser, while those from the under-parts are invariably finer and softer, and it is an undoubted fact that many of the latter have a strongly-marked, wool-like structure. I know of no animal which exhibits this difference in the character of the hairs from different parts of the body in so striking a degree as the Hedgehog (*Erinaceus europaeus*), for in that animal we have a gradation from stout spines to the softest and finest hairs, and the histological structure is equally varied. There is, however, another animal, much more familiar to us, which exhibits a similar wealth of variety in the structure of the hairs from different parts of the body, and the drawings of the hairs of the cow which are given as illustrations (see Figures 262 and 263), will fully bear out this contention. There we have gradation in a remarkable degree, as there are large coarse hairs with strongly-marked medullary cells, but with very slight indications of the overlapping cortical cells, through others in which there is a gradual diminution of the former structure and a corresponding increase in the latter, until finally we arrive at those showing the full characteristic structure of fine wool. From the article "Wool" in the "Encyclopaedia Britannica," I quote the following, which states the case very succinctly—"At what point, indeed, it can be said that an animal fibre ceases to be hair and becomes wool, it is impossible to determine, because in every characteristic the one class by imperceptible gradations merges into the other, so that a continuous chain can be found from the finest and softest merino to the rigid bristles of the wild boar." It might be thought that the question had an academic interest merely, but such is not the case; circumstances have been brought to my notice which prove that it is also of some commercial importance. Some time ago, one of our largest manufacturers of felt submitted to me a sample for microscopical examination. He had previously contracted to supply to a German merchant, a felt *free from wool*, as the tariff on all goods containing wool was absolutely prohibitive. On arrival at the German port, it was examined by the experts of the revenue authorities and refused admittance except on the higher scale, on the ground that it contained wool. Then ensued a deadlock, as the merchant refused to accept delivery on what, to him, would have been prohibitive terms. It was a sample of this felt which was submitted to me, after having been sent to a Liverpool analyst, who suggested that it was rather a matter for a microscopical specialist than for a chemical analyst. It was submitted with an assurance that no wool had been used in its manufacture. On examination, it was composed, according to my view, of cow's hair and jute with a small percentage of flax and *wool*. A report was given to this effect, which, of course, was unsatisfactory, as one was desired certifying to the total absence of wool. Shortly afterwards, another sample was submitted, the materials of which had been mixed under the close personal supervision of the head of the firm, who gave me his word of honour that absolutely no wool had been used in the making of that particular sample of felt. Again wool was found, roughly to the extent of about four or five per cent. This was inexplicable, and I was assured that there must have been a mistake somewhere, and a delicate hint was given that it could hardly have occurred at their works. Separate samples of the materials used in its manufacture were then asked for, and in the cow's hair was found what was unhesitatingly pronounced to be *wool*, and it was suggested that this was probably the source of contamination and the explanation of the apparent discrepancy. I was assured, however, that no admixture of wool had taken place at their works, and that the considerably higher price of wool (at least four times the price of cowhair) was a sufficient guarantee for the honesty of the merchant from whom the cowhair had been purchased. The matter could hardly be allowed to rest here; for, not to mention one's reputation, which it was evident had suffered some diminution, there was still no explanation forthcoming as to the undoubted presence of wool, and my interest being by this time thoroughly aroused, I could not be content without following the matter up until a solution of the difficulty should be arrived at. On thinking the matter over, I determined to procure hairs from different parts of the cow direct, with the satisfactory result that from various parts, but especially from the flank, I was both astonished and delighted to find that a considerable proportion of the hairs had all the characteristics of sheep's wool. To fortify my own dictum, I sent off specimens of this wool-like cow's hair to several friends who are experienced microscopists, one of whom undertakes chemical and microscopical analyses for commercial men, and in every case it was unhesitatingly pronounced to be *wool*. I am not aware that the fact has been previously noted, and as the matter appears now to have some commercial, as well as a scientific, interest, this record may be considered as not without some value. It is also gratifying to note that the German revenue authorities, on the result of this modest piece of research being submitted to them, have intimated that similar qualities of felt will now be admitted free, if accompanied by an affidavit to the effect that there has been no addition of sheep's wool. As a result, several consignments have been made on this undertaking, and although on one or two occasions there has been some correspondence, the arrangement, I believe, still continues. It would appear from this that our German friends are now willing to consider that wool-like hairs, if not from the sheep, are not *wool*, but they may readily be excused, I think, if the practice gets commoner, or if our manufacturers should utilise other animal hairs of a somewhat similar character, if, for revenue purposes at all events, they should revise their definition and insist that all wool-like hairs, from whatever source, are *wool*.

J. E. LORD.

THE PREPARATION OF SNAILS' TONGUES FOR THE MICROSCOPE.—Every snail, and almost every mollusc (except the Pelecypoda), bears upon its tongue a number of symmetrically-arranged rows of teeth, with which the food is rasped into a form convenient for ingestion. These teeth are generally hook-like in form, whence they are called unci. There is a central row, seen in the embryo of *Physa* to be formed by the coalition of two side rows; and the rows which border upon the central row are generally of a different type to the outer ones, so that there is a more or less clear differentiation into admedian and external rows. It would have been in accordance with the rules of anatomical nomenclature to call the outer rows lateral, rather than external; but unfortunately many authors have used the term lateral for the admedians. In the case of *Physa*, which we have some reason for calling a very primitive form, there are no admedians, and all the unci are pectinated. This pectination is less regular in Limnaeids; in *Succinea* and the Helices it undergoes a peculiar modification; in the Arions (perhaps derived from the Helicid stock) it is nearly lost; while it undergoes a different kind of modification in *Vitrina* and *Limax*, and in *Zonites* only appears as a teratological reversion. In *Testacella* it is not found at all. Indications are thus supplied from which a classification of the Pulmonates may be sketched out; and into such a classification the other anatomical characters appear to fit very well. It has been objected that the nature of the food of the species determines the type of radula. I believe that this may very well be the case, but that the nature of the food is itself a most important evolutionary factor; that changes in this respect are likely to be slow and not abrupt; and that the whole of the organism, including the reproductive and tegumentary organs, will have reacted in harmony with such changes. According to this view the main evolutionary changes have been brought about by what is ultimately a chemical factor; while there is much reason for supposing that many useful and decorative modifications may have originated in sudden mutations, and it seems likely that if we could more fully examine these mutations, we might set them down as due to physical factors. In the last resort no doubt it would be impossible to distinguish between the chemical and the physical; but still it appears a plausible view that changes depending upon factors of a smaller order should be slow and fundamental, while changes depending upon larger and compound factors might be more

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rapid and sudden, though less permanent. And it is further conceivable that changes due to factors of intermediate orders might occur; so that essentially Darwin and his later critics might both be right. I have accumulated a number of obser-

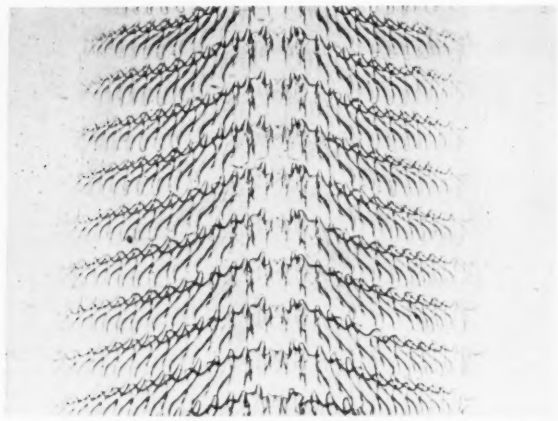

FIGURE 264.

Radula of *Zonites scharffi* Kennard. In paraffin.

tions upon these points, starting with the snails' tongues as text; since circumstances do not permit me to pursue the matter at present, it seems well to thus lay the skeleton of my conclusions before the readers of "KNOWLEDGE." There is another very interesting point that is brought out by the comparative study of radulae. There are strong indications that the inter-relationship of all these molluscs is in reality much closer than systematists would be inclined to allow. Science is description, and much of it has become very minute description; but it may be that in the near future more energy will be expended on the study of possible evolutionary factors than on the careful search for (unexplained) specific differences, or on the construction of elaborately artificial classifications. These remarks may tend to show that the snail's tongue offers a fertile field for investigation to the microscopist

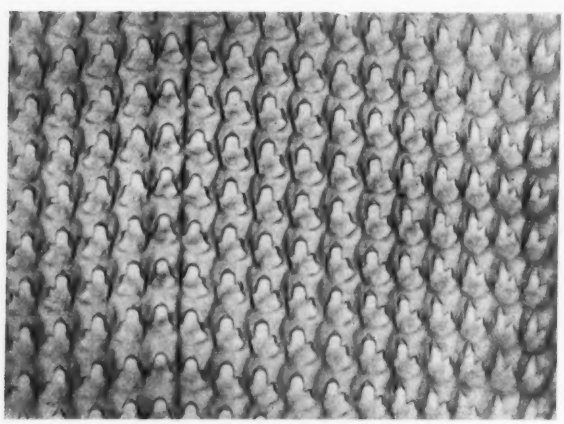

FIGURE 265.

Radula of *Helix fusca* Mont. In paraffin; small aperture.

who is slightly predisposed in favour of beautiful objects, and at the same time has a preference for a line of study which may have a direct bearing upon questions of scientific philosophy. The object of this note is to point out the interest of the subject, and to describe a method of making permanent preparations which is the result of many years of experiment. There are, of course, other microscopical objects to which the same remarks will in a measure apply.

The first practical question to decide is whether the structural details are to be rendered visible by differences of refraction, or by dissimilar absorption; in other words, whether we are to deal with them as stained or as unstained objects. The suggestion is often made that these two methods should be combined, so that one has a stained object mounted in a medium of refractive index higher or lower than its own. Let a radula of *Limnaea stagnalis* be stained with carbol-fuchsin and mounted in monobromide styrax; or let an ordinary stained section be mounted in some resinous medium of lower refractive index than Canada balsam. The result is that one has a preparation that can be examined as a stained object, and also as an unstained one; and if in any case it is important to be able to change from one style to the other by the simple means of opening and shutting the iris of the condenser, this combination may be desirable; but it must be added that the specimen which has these double properties is not so good for either purpose singly as the specimen specially mounted for observation in one or other of the two ways. It may be noticed here that if a specimen is to be examined with polarised light or by dark-ground illumination, the visibility of its details may generally be augmented by staining it with a fluorescent stain. This looks as if the stain was merely adsorbed, and had no chemical reaction with the tissue.

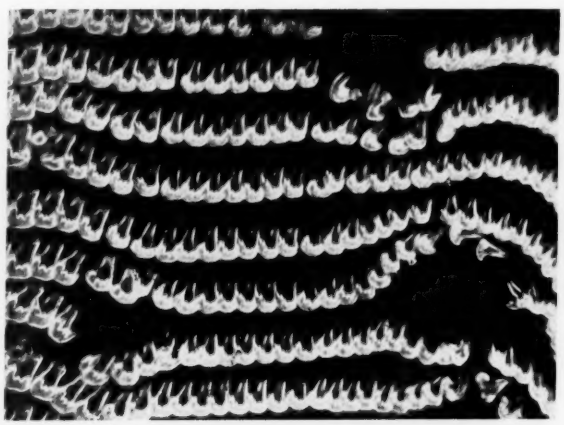

FIGURE 266.

Radula of *Succinea elegans* Risso. In paraffin. Zeiss dark-ground condenser.

With objects mounted for refraction contrast, the actual numerical aperture has a distinct influence on the formation of the image by contrast of refraction, according to the angle of delivery of the rays. A radula in paraffin, for example, may be clearly seen as a black object with a very low power, having condenser and objective equally balanced; contrast sufficient to show details may be evident when this is exchanged for an objective of N.A. ·20, the condenser being opened to match; exchanging further for an objective of N.A. ·30, and again matching, the outlines seem inclined to disappear, though what you do see is very sharp; but when you get to N.A. ·85 it may be impossible to see anything by contrast without shutting down the condenser iris. However, the phenomenon does not stop there, for if now you exchange for an oil immersion of N.A. 1·30, you will again see the contrast image, without any shutting down of the condenser aperture, this being made equal to that of the objective by the usual means. On the other hand, the improvement in definition obtained by using objectives of higher numerical aperture on stained objects in a homogeneous medium, is progressive and continuous, the entire aperture being used. Here, obviously, it is not possible to improve definition by any closing of the iris; where this plan appears to give improvement, it is due either to contrast effect obtained between two elements of the preparation which do not happen to be of exactly the same refractive index, or to a deficiency in the

objective, which ought to have been provided with a smaller internal diaphragm.

Any microscopist who will critically examine radulae or other small objects in various media can confirm these statements. Air, water, salt solution, glycerin in various dilutions, chloral hydrate mixtures, glycerin jelly, paraffin, dammar, colophonium, bergamot oil or turpentine dilutions of these last two, serve to exemplify media of low refractive index; of these I have found paraffin (as recommended by Dr. Coles, "KNOWLEDGE," Vol. XXXIV, page 192) to be by far the best, and glycerin jelly by far the worst, on account of its instability, the action which (as an aqueous medium) it has upon the glass, its want of transparency, and the difficulty with which it is removed from the object when it is desired to remount. Of media possessing higher indices than balsam, I have tried styrax, styrax in monobromide of naphthalin, the monobromide alone, and methylene diiodide. These are optically better, on the ground that they give better definition in depth, which is often greatly desired in photography; but for ordinary use they are ineligible, the best being the monobromide styrax, which, however, has the grave disadvantage of depositing gum after a time, besides undergoing a change not yet sufficiently investigated. I recommend that objects to be viewed by contrast shall be well dehydrated and brought into paraffin. If no more than the requisite amount of paraffin be used, there is no need to secure the cover. Paraffinum liquidum, not fluorescent, can be obtained of any chemist. If remounting is necessary, it is perfectly easy to wash the preparation in xylol, when it may be treated in any of the usual ways. Mounting in paraffin is thus extremely simple and good as a temporary method. The liquid penetrates a dehydrated specimen with great ease, and remains unchanged. To complete the dehydration of larger specimens it is well to clear with creosote or clove oil. Paraffin specimens are best for photographic purposes.

FIGURE 267.

A photo-micrograph of a living Crustacean (*Cyclops*) taken with the camera seen in Figure 268. Exposure half-a-second.

In accordance with the considerations adduced above, the definitive method will consist in mounting the specimen, after staining, in Canada balsam. Now, therefore, it only remains to describe the staining. A radula boiled out in caustic alkali will be already fixed to some extent. Almost any stain will now colour the newly-formed end of the organ. The rest of the structure will not stain regularly with any reagent. It will do so, however, and in a definite way, after a second fixation, or mordanting. Any of the usual histological fixatives may be used, or plain solutions of potassium bichromate, permanganate, or iodine. Tincture of iodine gives very good results, and should be applied for such a time that after washing out with absolute alcohol the structure is still distinctly stained yellow. Stain next with Biebrich Scarlet until the basal-plates throughout are strongly coloured. Remove superfluous stain with cigarette paper, and wash in absolute alcohol until no more stain comes away; a drop or two will suffice for this purpose. The newly-formed unci will now be seen coloured a brilliant red, and the basal-plates throughout with a duller red; this colour is fast. Wash again with distilled water, and stain for some time in an aqueous solution of thionin; this will not affect the parts already stained, but will clearly colour the points or pectinated parts of the unci. The preparation so made shows all the detail that is desired; there is no uncertainty about any part of it, and optical illusions are reduced to a minimum. You may focus through the specimen and thus optically dissect it.

It is perhaps desirable that some other stain should take the place of thionin, which might be fugitive in Canada balsam. But in this case, perhaps, the thionin has formed a compound with the iodine; it is certainly dislodged less easily than from sections. In any case, it is probable that a substitute of undoubted permanence could be found. Mordanted specimens may also be stained with Kernschwarz, when they can be photographed. A balsam specimen stained ten years ago in gentian violet is still as good as ever: but it will be noticed that the particular object of the Biebrich scarlet and thionin succession is to provide a selective staining of different elements. For this it is necessary that the first stain should colour only new-formed unci and basal-plates, and that the second stain should form no compound colour with the first, nor wash it out. It is plainly impossible to represent the contrasting colours by simple photographic methods, but they serve most materially to elucidate the structure. Radulae fixed in bichromate may be stained yellow with osmic acid; this yellow colour may be "developed" to black by means of pyrogallol. This method, originally suggested by Bolles Lee in 1887, gives most excellent results with radulae which show but small basal-plates. It is probably the best method for Pectinibranchs.

FIGURE 268.

A new instantaneous photo-micrographic Camera.

Radulae can be fixed to the glass of the slide by covering them with a drop of bichromate when they have been arranged on the slide, and allowing it to soak well into them (two or three minutes). This must be done by dim or red light. Now cover and expose the back of the slide to sunlight, so as to cause the formation of the insoluble chrome compound in the membrane. Drain off the superfluous liquid and leave to dry. On subsequent washing the specimens should be found well fixed, in both senses. The cover used in this process may be another slide tied on the first, and a thin film of paraffin on its inner surface prevents the front of the radula from sticking to the cover.

The image-erecting dissecting microscope with Porro prisms is of the greatest value for dissecting out radulae and in all mounting processes.

E. W. BOWELL.

A NEW INSTANTANEOUS PHOTO-MICROGRAPHIC CAMERA.—At the meeting of the Royal Microscopical Society, held on April 17th, Mr. F. Watson Baker exhibited a new reflex photo-micrographic camera for the instantaneous

photographing of living objects. The apparatus is shown in Figure 268 which we owe to the courtesy of Messrs. Watson and Sons. Inside, a surface-silvered mirror set at an angle of 45° projects the image of the object on to the ground glass screen seen on the left hand of the illustration. The shutter of the dark-slide can be drawn as soon as the mirror is set. When the release is worked the mirror covers the screen and the exposure is made and terminated by the falling of a flap. The exposure can be made very short if desired, but as a rule in practice it is about one or two seconds. The photograph which is reproduced in Figure 267 was taken on an Imperial Rapid Plate and the exposure was half-a-second, the light being obtained from a Duplex oil lamp. To set the shutter for time-exposures, it is manipulated in the ordinary way and then the lever C. shown in Figure 268, is turned so that it points vertically to B. On pressing the release, the shutter is opened and will remain so until the lever is brought back to A.

It will be obvious that this excellent little camera can be used on many occasions where there is no need for instantaneous work and it will be a convenience to those who are accustomed to use an ordinary camera that the focusing screen is vertical. Messrs. Watson & Sons are to be congratulated on the production of this simple, effective, and compact piece of apparatus.

QUEKETT MICROSCOPICAL CLUB.—On April 23rd, Mr. A. W. Stokes exhibited and described several methods of adapting electric lighting to microscope illumination. In one case the lamp, enclosed in a metal tube open at one end, was fixed to an adjustable arm attached to the stand. When once focussed on the object it remains so. If an ordinary supply of current was not available, the use of small pocket batteries was recommended. These gave four hours' light at a cost of fourpence, and the cell was easily renewed.

John Stevens, F.R.M.S., read "A note on *Notommata gigantea* Glascott." This rotifer, a true parasite, is only found in the ova of water-snails, and the communication was a series of notes of observations made in June, 1911.

Dr. Duncan J. Reid discussed "Illumination in critical work with the microscope." The subject was treated under the following heads:—The most suitable light, collecting lenses, the principles of correct illumination (*a*), as regards the field and (*b*), filling of the objective with light, condensers, distance of lamp from mirror, critical and non-critical illumination, working aperture and general arrangement of light and apparatus in high, medium, and low power work.

C. D. Soar, F.R.M.S., exhibited coloured figures of the fifty species of *Arrhenurus* recorded in the British Isles.

ORNITHOLOGY.

By HUGH BOYD WATT, M.B.O.U.

WINTER MOVEMENTS OF THE GANNET IN THE OUTER HEBRIDES.—Mr. Robert Clyne, lightkeeper at the Butt of Lewis, in a recent article in *The Glasgow Herald* has given a vivid sketch of the movements of this great bird "midst furthest Hebrides." He writes:—"Gannets are never altogether absent from our shores, though they are rarely seen during the three winter months. Borne west and north by south-east gales, they were seen by mid-February passing the Butt of Lewis, flying out into the North Atlantic, having been absent from the locality for only a few weeks. Their annual extraordinary procession up the Minch, round the north of Lewis, and out in a south-westerly direction to their breeding haunts—St. Kilda principally—is not due until about the middle of March. At the Butt of Lewis they all appear as coming up the Minch, but doubtless the majority will collect from the North Sea, rounding Cape Wrath, keeping well, as is their habit, to the contour of the land, till near the Lewis coast they converge with others into one continuous stream. Hugging the land at the extreme north end of the Lewis, many pass through a narrow channel—a veritable gannet highway, for over it flocks pass all summer going to and from their feeding grounds."

SUCCESSFUL PROTECTION OF BIRDS.—We gather the following satisfactory items from the recently-issued Annual Report for the year 1911 of the Royal Society for the Protection of Birds. At one of the few remaining breeding-places of the Chough, eleven pairs were seen instead of only three pairs as was the case when the work of protection by a watcher was started; and in the Shetland Islands the Great Skua had increased largely in numbers, while Richardson's Skua was now plentiful (Mr. E. G. B. Meade-Waldo). There were now at least eight pairs of kites where nine years ago only two pairs and an odd bird existed. In a certain area in the same period of time, Buzzards are estimated to have increased from forty pairs to seventy pairs. Ravens had done exceedingly well, and Barn Owls were again becoming numerous (Rev. D. Edmunds Owen). An extraordinary increase in the winter flocks of Goldfinches and Siskins in Scotland was reported by Sir Herbert Maxwell.

ARRIVAL OF SUMMER-BIRDS: A COMPARISON.—The following list gives the dates of the arrival of some of our earliest summer visitants up to the end of April this year. The English dates are mostly from the columns of *The Field* and the Scottish ones are from a report made by Mr. John Paterson to the Natural History Society of Glasgow. The list is confined to birds occurring in both districts, and therefore many kinds known in England are not included in it. In a general way it confirms what is known as to the differences consequent upon the geographical situation of the two districts, but reports the White Wagtail and Corncrake are earlier in the North than in the South.

	West or South of England.		West of Scotland.
Chiffchaff	10th March	... ...	14th April
Wheatear	18th ,,	... ...	1st ,,
Whinchat	26th ,,	... ...	26th ,,
Sand-Martin	27th ,,	... ...	5th ,,
Ring-Ouzel	29th ,,	(Windermere)	26th ,,
Swallow	30th ,,	... ...	12th ,,
Yellow Wagtail ...	1st April	... ...	19th ,,
Cuckoo	6th ,,	... ...	18th ,,
Willow-Wren	6th ,,	... ...	15th ,,
Common Sand-piper	7th ,,	... ...	11th ,,
White Wagtail ...	10th ,,	... ...	5th ,,
Tree-Pipit	14th ,,	... ...	23rd ,,
Wood-Wren	23rd ,,	... ...	28th ,,
Corncrake (Land-rail	23rd ,,	(Co. Mayo) ...	19th ,,
Swift	26th ,,	... ...	28th ,,

NEW LIST OF BRITISH BIRDS.—Messrs. Witherby & Co. have just published "A Hand-List of British Birds," giving a detailed account of the distribution of each bird in the British Isles, and a general account of its range abroad, together with details of the occurrences of rare species. The Hand-List is the joint work of Messrs. E. Hartert, F. C. R. Jourdain, N. F. Ticehurst, and H. F. Witherby.

PHOTOGRAPHY.

By EDGAR SENIOR.

EXPOSURE TABLE FOR JUNE.—The calculations are made with the actinograph for plates of speed 200 H. and D., the subject a near one, and lens aperture F.16.

Day of the Month.	Condition of the Light.	Time of Day. 10 a.m. and 2 p.m.	8 a.m. and 4 p.m.	6 a.m. & 6 p.m.	5 a.m. and 7 p.m.
June 1st	Bright	·09 sec.	·12 sec.	·24 sec.	·48 sec.
,, ,,	Dull	·18 ,,	·24 ,,	·48 ,,	·96 ,,
June 15th	Bright	·09 sec.	·12 sec.	·24 sec.	·43 sec.
,, ,,	Dull	·18 ,,	·24 ,,	·48 ,,	·87 ,,
June 30th	Bright	·09 sec.	·12 sec.	.24 sec.	·43 sec.
,, ,,	Dull	·18 ,,	·24 ,,	·48 ,,	·87 ,,

Remarks.—If the subject be a general open landscape, take half the exposures given here.

PHOTOGRAPHY WITH A MICROSCOPE.—Photography from quite an early period of its existence appears to have been employed to secure images of microscopic objects, for we find it stated that Wedgewood and Davey in 1802 obtained photographic records by means of the solar microscope, employing paper rendered sensitive to light by treatment with a solution of silver nitrate. They found that images of small objects could be produced without difficulty in this way. Thus, among the very first experiments in photography was the aid of the microscope sought as a means for forming images intended to be photographed. Although so early in the field, photography with the microscope (photomicrography) can scarcely lay claim to have been the most successful of the many branches of photography. This may be traced to several causes. In the first place a microscope is primarily intended for use as an instrument for visual observations only, therefore its objectives and eyepieces have naturally been constructed to give the best results when employed in this manner. Such being the case those rays which are of such prime importance in photography are left outstanding, or in other words, are not united at the same focus as they are in the case of a photographic objective, with the result that a picture, sharp visually, would be wanting in definition when photographed, owing to chromatic differences of focus. Further, the great majority of objects have to be illuminated by transmitted, instead of reflected light, and the shortness of focus of the lenses, together with their smallness, renders the proper illumination of the objects anything but an easy matter, and this, together with the want of sharpness over the entire field "with any except low powers," has contributed to make photo-micrography less successful than is ordinary photography. So much attention, however, has been given to the subject of late years, that, what with the great improvements made in the construction of objectives, and the use of orthochromatic plates, and suitable light filters, excellent results can now be obtained with ordinary achromatic objectives, while the apochromats and projection oculars place in the hands of those, not specially skilled, a means of obtaining good results with comparative ease. The problem of illumination, too, has received so much attention from skilled microscopists, that many of the former troubles no longer exist.

FIGURE 269. A Rose Beetle. × 16 diameters. Photographed with a Zeiss Planar series I A No. 5. 100 mm. focus stopped down to F16.

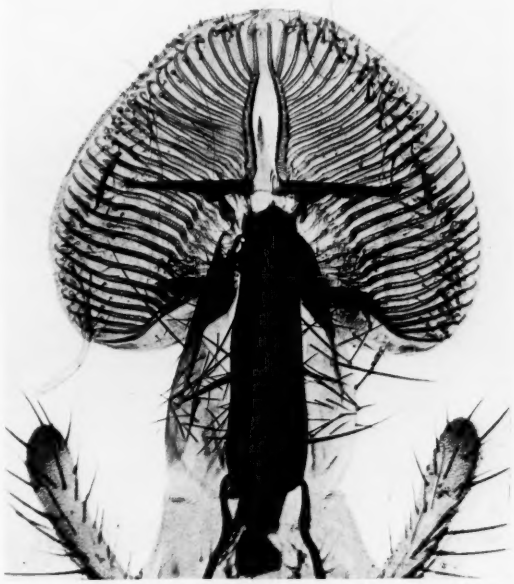

FIGURE 270. The Proboscis of a Blow Fly. × 40 diameters. Photographed with Messrs. James Swift and Son's 1-inch objective without eyepiece.

PHOTO-MICROGRAPHS AT A LOW MAGNIFICATION.—Many large transparent objects, insects, and so on, require to be photographed so as to show the entire specimen. These must be taken at a low magnification, and an objective employed which has a field sufficiently large to include the whole of the object, and in order to ensure successful results attention must be given to obtaining as uniform a lighting as possible. The illustration (Figure 269) is from an object photographed under the conditions necessary to include the whole of the specimen, and was taken with a Zeiss planar of one-hundred millimetres focus. This objective was screwed into the end of a conical tube and attached to the body of a Zeiss photo-micrographic stand, from which the draw tube had been removed. The source of light was a thirty-ampère arc lamp. To collect the light, a plano-convex condenser was placed in such a position that the emergent rays were rendered parallel. A second lens of shorter focus was then placed in the path of this beam, by means of which the light was made to converge, and fall upon a simple spectacle lens condenser placed in the sub-stage. By this means a uniformly-lit field was obtained, and by careful manipulation of an iris diaphragm placed in the path of the parallel beam, all light not required was excluded. On placing the specimen on the stage and focussing, a brilliant image on a perfectly evenly illuminated field was the result. A green screen was employed to give the necessary contrast, and an exposure of five seconds given, using an Imperial N. F. plate of speed two-hundred H. and D., the developer being Pyro-soda. In photographing the example shown in Figure 270, while the same general arrangement for illumination was retained the objective employed was a one-inch made by Messrs. James Swift and Son, of Tottenham Court Road. This was screwed into the lower end of the microscope, the light conical adapter still occupying the place of draw tube, which had been removed in order to avoid any internal reflections as well as restriction of field of view. In any case, when photographing without an eyepiece, if the draw-tube remains in position its end must be lined with black velvet to avoid these reflections. After carefully focussing the source of light, a perfectly illuminated field was obtained. The specimen was then placed upon the stage and focussed for those hairs which form the distinctive feature of

this celebrated test object. The iris diaphragm of the condenser was closed sufficiently to obtain more general sharpness. The original photograph, which is taken on an $8\frac{1}{2} \times 6\frac{1}{2}$ plate, is magnified eighty diameters. The camera extension was one hundred and sixty-three centimetres. A green screen was employed for contrast, and an exposure of twenty seconds given on an Imperial N.F. plate of speed two hundred and twenty-five H. and D. The negative was developed with Pyro-soda developer. The two examples accompanying this article are from negatives taken at the first of the series of practical demonstrations on photo-micrography given at the South-Western Polytechnic on Monday, May 6th, and must not be regarded as the best that could be obtained, when more time could be spent in the adjustment of apparatus than is possible when demonstrating before a class. They are, however, good, and serve their purpose perfectly, in illustrating as they do the application of photography in low power photo-micrography.

PHYSICS.

By ALFRED C. G. EGERTON, B.Sc.

ACTIVE NITROGEN.—In the *Proceedings of the Royal Society* are to be found further accounts of Professor Strutt's experiments on "active" nitrogen. It appears that "active" nitrogen is nitrogen in the atomic condition, and not polymerised as oxygen is in ozone (O_3). Oxygen destroys the nitrogen glow; which glow appears to be the luminosity afforded by the process of passing from active to ordinary nitrogen, or in other words, to combination of nitrogen atoms. The oxygen does not appear to actually combine with the nitrogen, but acts as a catalyst and hurries the production of ordinary nitrogen. One very important result is that active nitrogen appears to play no part in the production of oxides of nitrogen by the spark discharge. Hydrogen only dilutes the nitrogen and does not take part in the action ($N + N = N_2$). Nitric oxide combines with active nitrogen, giving a greenish-yellow flame, due to the nitrogen peroxide produced, in all probability. Fourteen parts by weight of "active" nitrogen give seventy-six parts of nitrogen trioxide and consequently the amount of active nitrogen is about 2·5 per cent. of the total nitrogen present. The active nitrogen has the property of developing the metallic spectra when certain volatile metals are heated in it; ozone is known to do this also in some cases, but all attempts to isolate active nitrogen by condensation in liquid air have not succeeded. The spectrum is simpler than the ordinary nitrogen spectrum; and considerations such as these point to the probability of active nitrogen, being nitrogen in the atomic condition.

The writer has noticed that the flame of ammonia burning in oxygen has several peculiarities, which lead to the idea that the first action—the action going on in the inner cone giving a yellow luminosity—is merely the splitting up of the ammonia into hydrogen and nitrogen atoms, which then combine as in the case of active "nitrogen." The flame has a colour and spectrum similar to that of the active nitrogen glow; the shape of the inner cone is always such that it exhibits a rounded appearance indicating that it is a decomposition rather than a combustion with upward rising gases which produces pointed flames. There is a considerable amount of nitrogen peroxide produced, but this would probably be due to the combustion of the molecular nitrogen and oxygen; but the main products of combustion are nitrogen and water. A small yellow streak of the same colour is noticeable in the flame of burning cyanogen between the pink and violet cones, and may be due again to some re-combining atoms of nitrogen. In these cases it is necessary to distinguish the yellow flame due to the production of oxides of nitrogen and the glow due to recomposition of nitrogen atoms.

SPECTRA.—Much work has been done recently on the shift of the lines in the spectra of metals by the effect of pressure. Pressure would at first sight only appear to change the molecular conditions of a substance, and could hardly affect the vibrations within incompressible atoms. However, as Professor Richards and others have pointed out, it is a fallacy to assume an incompressible atom, and it would seem that the change of wave-length of light emitted from atoms under high pressure is caused by a change in those properties of the atom which depend on the specific inductive capacity.

Coblentz has recently examined the luminous efficiency of various gases contained in vacuum tubes, through which an electric current is passed. The luminous efficiency of air, carbon-dioxide, helium, and so on, is of the order fifteen to twenty per cent., owing to a major proportion of the energy being distributed as infra-red radiation. The infra-red radiation in neon is almost entirely absent, and the luminous efficiency is upwards of ninety per cent.

Professor Jones has given an account of some work on absorption spectra and the solvate theory of solution in the May number of *The Philosophical Magazine*. A salt dissolved in a given solvent is characterized by a definite absorption spectrum: when such is dissolved in varying mixtures of two solvents only two definite absorption spectra appear, one being characteristic of each solvent; only the relative intensities of these two spectra change on changing the relative proportions of the two solvents. Thus neodymium chloride dissolves in alcohol and in water, giving rise to methyl-alcohol bands and water bands, the intensity of which depends on the amount of methyl-alcohol and water present; it appears that there is evidence in favour of the view that there are definite hydrates and alcoholates in solution. The solvate theory of solution which is being developed by Jones and his pupils supplements the theory of electrolytic dissociation, and is not at variance with it.

Havelock has found that the departures from Kundt's rule, that the greater the refractive power of the solvent the greater the shift of the absorption bands of a solute towards the red, are due to the formation of molecular aggregates. It is well known that Kundt's rule is only true for a few substances in dilute solution.

ZOÖLOGY.

By PROFESSOR J. ARTHUR THOMSON, M.A.

SKIN OF HAIRLESS DOGS.—Darwin and others have directed attention to the occurrence of hairless dogs, especially in warm countries. They are often called by such names as "Egyptian" and "Chinese," and many of them show very abnormal development of the teeth. A study of the skin of such dogs has recently been made by F. G. Kohn, who finds in the new-born puppy (1) a variety of stages in hair-development in a state of arrest, and (2) an abnormal development of horny material and an abnormal distribution of pigment. On the one hand, the skin is like that of a young embryo; on the other hand it is abnormal. The condition is not a gradual adaptive diminution of hair, such as may have occurred in the case of man. It is an abrupt hereditary "mutation" of unknown origin.

FEATHERS AND SCALES.—Aristotle discerned the deep-seated sameness of feathers and scales, and the view that they are homologous has been generally accepted. But it is not without its difficulties, for the development of the feather, though much nearer that of a scale than that of a hair, is very distinctive. And there are no transitional types between scale and feather. The minute flat feathers on a penguin's wings are no nearer scales than are the plumes of an ostrich. Some light has been recently thrown on the question by Frieda Bornstein's careful study of the foot of the capercaillie where feathers and scales occur in such close association. The conclusion reached is this, that a feather corresponds not to an entire scale, but to part of a scale, another part being suppressed. The same view has been previously maintained by Ghigi.

ALLEGED RUDIMENTS OF TEETH IN MODERN BIRDS.—The fact that teeth occurred in the oldest known fossil bird (*Archaeopteryx*), and in many of its extinct successors as well, has led to a repeated search for hints of

teeth in the embryos of modern birds. From time to time since Geoffroy St. Hilaire, it has been announced that in embryos of parrots and terns, and some other birds, traces of tooth-germs occur on the jaws. Dr. Ihde has recently re-investigated some of the alleged cases and with quite negative results. Distinct papillae sometimes occur, but they are in no sense tooth-germs. They show no hint of dentine, and they do not develop as teeth do. The "dental ridges" described by Röse have to do with the development of the horny bill; they are not comparable to the true dental ridges of mammals.

MEMORY IN FISHES.—Mieczyslaw Oxner has experimented with the sea-perch, *Serranus scriba*, in the following fashion. He hung in an aquarium a red and a green cylinder by silk threads of similar colour, and put food in the red one only. For the first two days the fish did not approach the cylinders; on the third day, after fifteen minutes, it entered the cylinder and ate the food; on the fourth day it did this after five minutes; on the fifth day after half a minute; from the sixth to the tenth day it rushed in at once. On the eleventh day it entered a fresh red cylinder which had no food, and waited there for three minutes. An association had been established between the colour and the food. The fish rushed into the empty red cylinder on each of the succeeding six days, and when M. Oxner dropped in some food a little was taken. On the eighteenth, nineteenth, and twentieth days, the fish would not eat the food. Even in the absence of appetite, the fish seemed unable to resist rushing into the red cylinder. In other experiments the colours were altered, but the same general results were obtained. There is no particular attraction in the red colour. What is established is first an association, and eventually something almost like a reflex.

BODY-POISON OF SPIDERS.—It has been known for some time that extract of mashed spiders contains a poison—arachnolysin—which has a destructive action on blood corpuscles. Robert Lévy has recently shown that the body-poison is confined to adult females, is particularly localised in the ovary, and is got rid off in the eggs. It is readily obtained from the eggs of the garden spider, for instance. From the eggs the arachnolysin passes on into the young spiders, but then it disappears—altogether in the males, and until maturity approaches in the females. This body-poison and egg-poison is not to be confused with the poison which all spiders have in their poison-glands. Lévy's facts doubtless form a contribution to the physiology of sex, but it is difficult to discern their significance. There are analogous facts in regard to some other animals. Thus Phisalix found that in female toads the toxins normally secreted by the cutaneous glands are localised in the ovary and pass into the spawn. They disappear, however, in the tadpoles.

SENSITIVENESS OF BLOW-FLY.—It is well known that the blow-fly (*Calliphora vomitoria*) has an extraordinarily keen sensitiveness to the odour of flesh, detecting it from a distance. Xavier Raspail has made some observations on the rapidity with which the flies find a bird that has just died and he maintains that they do not alight a second before that. An apoplectic pigeon that looked dead, but was not, was left unvisited. A moribund magpie, lying beside two others which had just been killed, was left unvisited though the flies were on the dead birds just beside it. The instinct not to lay eggs in anything not quite dead seems to be strongly developed. But Raspail goes on to draw the hazardous conclusion that in the article of death an animal gives off a volatile something of infinite subtlety which serves as a clue to the fly.

REVIEWS.

ASTROLOGY.

Chaldean Astrology. — Second edition. By G. WILDE. 150 pages. Numerous illustrations. $8\frac{1}{2}$-in. × $6\frac{3}{4}$-in.

(T. W. Laurie. Price 6/- net.)

This is one of a series of books on Psychical Research with which we have no sympathy. For the elevation and preservation of the mental character and respect of mankind we would rather this useless subject of horoscopes and its allies were as dead as the ancient Aramaic race which inhabited the mountain regions near Ararat. We would also have preferred to have let the printing and dissemination of astrological works, except as an exercise in exposing the mythological origin and its close associations with witchcraft, sorcery, and similar abominations, cease with those ingenious concoctions published in the sixteenth century, with which we are acquainted. In the regeneration of the Chinese nation it is most earnestly desired that one of their greatest errors—their continued addiction to astrological notions—may be swept away for ever, and that a wholesome knowledge of the heavenly bodies may occupy their attention instead of the practice of this "occult science." The writer of the preface says "it is not intended to denounce or discourage the pursuit of occult studies"—of course not, or away would go the profits derived from such books as this—"but simply to insist that they have nothing to do with astrology, which is a physical and verifiable science or it is nothing." It is nothing but a delusion.

The preface also says: "The author possesses as much experience, as much ability, and what is equally important, as much candour and love of truth as will easily be found in any contemporary astrologer." We have no doubt whatever upon this point. We would like to emphasize this and add "or from the time of the tablets of Sargon I of Agadi, B.C. 3800." No, this would not be quite true. The poor ancient folks only had the sun, moon, and five major planets with which to work out their schemes. It is quite alarming to meditate upon the enormous amount of misconception, misinterpretation, inefficiency, and disturbance upon human lives in the horoscopic prognostications of the period previous to the discovery of Uranus in 1781 by the non-horoscopic Herschel, and by the discovery of Neptune in 1846. It will be interesting to watch the re-arrangement of the "houses" when a new lord of the ascendant, "significator," is discovered as the ninth major planet, also how it will act as a "promittor." We offer a suggestion. As the seventh major planet was discovered with a telescope, the eighth by mathematical calculation, will the horoscopists discover the ninth by deduction from the falsities, anomalies, and inexplicabilities in their present forecasts, and indicate to astronomers where we may see that planet? We might "horoscope" its name as "Horoscopia."

When we first perused this book we thought of conjuring our horoscopes according to the accommodating data given—passing thoughts make us think of some of the well-known patent medicines which cure or soothe opposite ailments—but we have come to a definite decision, that as we believe we are greatly controlled and *our* lives influenced by the *ninth* planet we must reluctantly wait until its discovery (by horoscopy, preferably). When one has an hour or more to waste it is an interesting book to read, as one can readily find something to satisfy for the moment, and dissatisfy for longer periods. It is astonishing that any but heathens and atheists can believe such stuff. So long as there are people with time and money, so long will such books be inflicted upon us. A short time ago a "prophet" named Voigt, wrote and published a work predicting the end of the world. He was justly prosecuted and heavily punished by the Berlin police for "spreading pernicious literature." Would that we had such a law enforced.

F. A. B.

EVOLUTION.

Evolution in the Past.—By HENRY R. KNIPE, F.L.S. 242 pages. 56 full-page illustrations. $10\frac{1}{4}$-in. × $7\frac{3}{4}$-in.

(Herbert & Daniel. Price 12/6 net.)

An immense amount of care and trouble has been expended in order to ensure that this book shall be at once attractive and reliable. The introduction gives a very clear and con-

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vincing account of the theory of Natural Selection, while the first chapter shows how multicellular forms arose from unicellular organisms. The bulk of the work describes the phases of life which were to be met with during the recognized geological epochs, and we are told how creatures appeared, developed and died out, or persisted, in some cases, to the present day, or again, left modified descendants whose genealogy we can occasionally trace in detail. We are certainly given facts, and that is why, perhaps, we should like to have had a little more theory as to how one group evolved in the past from another—how, for instance, birds were derived from reptiles. Imagination, tempered by the advice of experts, has had to have some play in the many full-page sketches by Miss Alice Woodward and Mr. Bucknall, which illustrate the volume. There is an absence of detail in some of these which is, perhaps, to be commended, for if features are not supplied, they cannot well be criticised. This remark one would say however, would not apply to the digits of *Archaeopteryx*.

We note that when discussing *Pithecanthropus*, which some consider to be hardly human, Mr. Knipe, not to be behind the times, calls it a super-ape. A feature of the book is the printing of the names of the various creatures discussed in the wide margins, and this adds to its general interest and usefulness. "Evolution in the Past" should be read and studied by all lovers of Natural History.

W. M. W.

MEDICINE.

Fourth Report of the Wellcome Tropical Research Laboratories at the Gordon Memorial College, Khartoum. Vol. A, Medical.—By ANDREW BALFOUR, M.D., Director. 404 pages. 101 figures. 22 plates. 10¾-in. × 8-in.

(Baillière, Tindall & Cox. Price 21/- net.)

It is now three years since the Wellcome Tropical Research Laboratories issued their last report. The present volume deals with medical subjects only, while a second part is given up to general science. The laboratories are situated at Khartoum, and besides a well-equipped main building possess also two specially-fitted steamers which are able to move wherever needed on the Nile. In his Annual Report for 1909 the Director-General of the Sudan Medical Department points out "what a valuable asset such a well-equipped laboratory, with well-trained observers, is in Khartoum," and the work done in the laboratories fully justifies this appreciation, for it is of the best, and the only wonder is how so much has been carried out in a tropical climate with so few assistants.

A large part of the report is given up to observations on the pathology of sleeping sickness, Kala-azar, "oriental sore," and other tropical diseases. But subjects of more general interest, such as diphtheria in the tropics, tropical sanitation and the water supply of towns in the tropics are also dealt with. In glancing through the report one is especially struck with the excellence of the microscopic observations described in it, and for readers outside the tropics the chapter on "Fallacies and Puzzles in Blood Examination" is, perhaps, of the greatest interest.

The report is well written—every page of it is readable and full of interest—and the illustrations are delightful. There are numerous diagrams and reproductions from photographs, and the twenty-two plates illustrating various blood parasites are for the most part beautifully reproduced in colour; there is also an excellent index. The report is absolutely indispensable to research workers in tropical countries.

S. H.

Second Review of some of the Recent Advances in Tropical Medicine, being a Supplement to the Fourth Report of the Wellcome Tropical Research Laboratories at the Gordon Memorial College, Khartoum.—By ANDREW BALFOUR, M.D., and CAPT. R. G. ARCHIBALD. 448 pages. 10¾-in. × 8-in.

(Baillière, Tindall & Cox. Price 15/- net.)

This is the second time Dr. Andrew Balfour and his colleagues have gone to the trouble of collecting together for us the results of recent work in Tropical Medicine and allied sciences, the first review appearing as a supplement to the Third Volume of their Reports in 1908. Fortunately, as is pointed out in the preface, it is most improbable that anything of this kind will be required again, for *The Medical Officer* now issues a monthly review supplement giving an excellent resumé of the current literature on bacteriology and protozoölogy.

The subjects in the Review are arranged alphabetically and at the base of each page full references of the matters referred to in the text are given. Besides this, there is a very complete index at the end of the book.

The value of a book such as the above depends almost entirely upon the completeness with which references to the subjects dealt with have been sought for and the care with which abstracts have been made from them. On the whole we are inclined to think the work has been very well done, but we should like to have seen at least some reference to the really valuable observations made by Beauchamp Williams on the bacteriology of leprosy. The only faults we have been able to discover, however, are faults of omission and these we think are not very numerous. We are sure that every worker in Tropical Medicine will feel that they owe to the staff of the Wellcome Tropical Research Laboratories a very great debt of gratitude.

S. H.

MICROSCOPY.

Microscopy and the Microscopical Examination of Drugs.—By CHARLES E. GABEL, B.S., PH. D. 122 pages. 71 illustrations. 8¼-in. × 5½-in.

(Charles E. Gabel, Iowa, U.S.A. Price $1.)

The number of books available for the student in any branch of microscopy is now considerable, but it is doubtful if any one of them attempts to cover so much ground in so little space as that now noticed. The result is, as might be expected, that the matter provided is, in nearly every instance, incomplete and unsatisfying. Barely four pages are together devoted to a description of lenses, microscopes, ultramicroscopes and photo-micrography, with the result that the student is left with the vaguest possible idea of the subject, much less of the principles governing the use of such appliances. The expressed intention is to provide a book that to some extent replaces the student's lecture note-book, and it may be that in this sense it will appeal to some readers; but it must be confessed that in other respects it will fail to be of service even to elementary students, as the matter provided is not put forward with sufficient scientific accuracy to form a good groundwork.

J. E. B.

Micropetrology for Beginners.—By J. E. WHINFIELD RHODES, B.Sc. 126 pages. 26 illustrations. 7½-in. × 5-in.

(Longmans, Green & Co. Price 2/6 net.)

The microscope is now becoming a universal tool in all branches of science, but perhaps in no direction has it achieved such satisfactory results as in Petrology and Metallurgy. No branch of work demands that the instrument should be more thoroughly understood, to enable the best work to be done, than Petrology, as its study involves the use of special appliances and methods. The book here considered provides the beginner with just the information required, the instructions on the use of the petrological microscope and the method of handling and using its various parts being concise and sufficiently explanatory. It will undoubtedly bridge over the gap that exists between general text books on Geology and the specialised books on Petrology. The description of a selected series of igneous rocks follows, and to the amateur, at least, it will be of interest to know, sets of slides to illustrate the work described can be obtained commercially. In every sense, the object in view appears to have been attained and the book may be commended as a guide to those commencing this interesting branch of microscopy.

J. E. B.

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ZOOLOGY.

Earth and her Children.—By HERBERT MANN LIVENS. Illustrated by Horace Mann Livens, Fanny M. Minns, Geoffrey Livens, and others. 248 pages. 92 illustrations. 7½-in. × 5-in.

(T. Fisher Unwin. Price, 5/- net.)

This is a nature-book for young children, conversational in its method, fanciful in its nomenclature, altogether pleasant and wholesome in its outlook. The text is both adorned and illustrated with interesting drawings. We have noticed that when birds and beasts and trees and flowers are made to answer questions in a book, some children are bored, while others not more imaginative are much interested. Those of the second mood will enjoy "Earth and her Children."

J. A. T.

The Ox and its Kindred.—By R. LYDEKKER. 271 pages. 55 illustrations. 7¾-in. × 5-in.

(Methuen & Co. Price 6/-.)

Mr. Lydekker will earn by this volume the gratitude of naturalists and breeders alike. For there has been a long standing need for a comprehensive and not too technical account of the breeds of domesticated cattle and their decipherable history. The author deals mainly with the extinct wild ox and the domesticated breeds, but three chapters are devoted to existing wild cattle, to hybrid cattle, and some extinct cattle other than the aurochs. He displays throughout his wonted competence and clearness. There are many difficult questions discussed, but Mr. Lydekker treats them without dogmatism in a judicial scientific temper. Thus, in regard to the much debated question of the British Park cattle, he lets the various views have their innings in turn. In his own opinion, "the half-wild cattle which are known to have roamed through the British forests in the time of Fitz-Stephen, but whose precise origin and relationships cannot now be determined, may perfectly well have given rise to the various park-breeds, without the intervention of imported breeds." All park cattle and the older British breeds are derivable, with or without the intervention of the Celtic shorthorn, from the exterminated aurochs (*Bos taurus primigenius*).

J. A. T.

BRIEF NOTICES OF BOOKS.

The list includes books which have been received since the last number of "KNOWLEDGE" went to press.

The Espérance Morris Book. Part II.—Edited by MARY NEAL. 48 pages. 12 illustrations. 12¼-in. × 9½-in.

(J. Curwen & Sons. Price 5/-.)

The efforts of Miss Mary Neal to revive Morris and country dances in England are well known. This book, edited by her, is the second part of one which has already appeared. It contains some reproductions of very interesting photographs with notes on tunes and dances which have been written by Mr. Clive Carey, who, with Mr. Geoffrey Toye, has collected the music which is printed in the volume.

Studies in Seeds and Fruits.—By H. B. GUPPY, M.B. 528 pages. 9-in. × 6-in.

(Williams and Norgate. Price 15/- net.)

Fruits always form a pleasing subject, though seeds are perhaps neglected by the nature student. Those who are attracted by either will find much of interest in this solid contribution to botany.

Peeps at Industries—Rubber.—By EDITH A. BROWNE. 7¾-in. × 5¼-in. 88 pages. 24 illustrations.

(A. & C. Black. Price 1/6 net.)

We hear so much about Rubber at the present day that a short illustrated account of its history and cultivation is most welcome and Miss Browne has dealt very interestingly and exhaustively with the many aspects of the subject, in the space at her disposal.

A Manual of Practical Bio-Chemistry.—By H. LEIGHTON KESTEVEN, D.Sc. 64 pages. 7-in. × 5-in.

(The Australian Book Co. Price 2/6 net.)

One hundred and one experiments are dealt with in the work. The laboratory directions form the bulk of the letter-press, which is printed on one side of the paper only so that it is possible for a student to cut them out and stick them into a note book.

A Class Book of Physical Geography.—By A. T. SIMMONS, B.A., and ERNEST STENHOUSE, B.Sc. 436 pages. 222 illustrations. 7½-in. × 5-in.

(Macmillan & Co. Price 4/6.)

Although assistance in the framing of this book has been derived from a study of the syllabuses of all the principal examining bodies, and the descriptive portions of the volume will be found complete as a text book, yet practical exercises are set out at the beginning of the various sections, and much of its educational value will be lost by students who neglect these for they will not become observers able to reason intelligently on the facts encountered.

The Lantern and How to Use it.—By C. GOODWIN NORTON and JUDSON BONNER. 146 pages. 93 illustrations. 7-in. × 5-in.

(Hazell, Watson & Viney. Price 1/- net.)

The lantern is so indispensable now and so many methods of obtaining a light are used, that it is necessary for anyone who wishes to project illustrations on to the screen to know something about the subject before making a choice of apparatus. The information required can be got from the book under consideration which has been brought up-to-date, and includes also many useful hints by which the would-be lanternist cannot but be helped considerably.

Tables Annuelles Internationales de Constantes et Données Numériques, Vol. I.—727 pages. 11-in. × 8¾-in.

(J. & A. Churchill. Price 21/6 paper, and 24/- bound in cloth).

We have received this important work and it is interesting to chronicle that it contains a series of postcards which can be torn out so that any reader may point out mistakes or omissions that he may possibly discover.

A School Algebra.—By H. S. HALL, M.A. 550 pages. 7½-in. × 5-in.

(Macmillan & Co. Price 2/6.)

The present instalment forms Parts 2 and 3 of the book. As in Part 1 very special care has been taken with the pagination. The matter is so arranged that it is never necessary to turn over in the middle of any particular paragraph, and so the reader is not once disturbed. This feature is probably unique, and not to be found in any other mathematical text book.

How to use the Microscope.—By CHARLES A. HALL. 88 pages. 20 plates. 7½-in. × 5¼-in.

(Adam and Charles Black. Price 1/6 net.)

The microscope is a tool which everyone should be able to use, whether for business or for pleasure, and any book which helps the beginner makes for good. At the same time it must be pointed out that it is more useful to introduce new observations than to repeat old ones, and hence we should have preferred that the illustrations, though they are excellent, should have been of a less hackneyed character. The proboscis of the blow-fly, the mounted flea, and the eye of a beetle have become too well-known. Though proverbs are often wrong, in this case familiarity does tend to breed contempt.

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Aristotle's Researches in Natural Science.—By THOMAS EAST LONES, M.A., LL.D. 274 pages. 10 illustrations. 8¾-in.×5¾-in.
(West, Newman & Co. Price 6/- net.)

The fact that some of Aristotle's views are held at the present day gives a particular interest to his work, and Dr. Lones deals with it in detail.

Bush Days.—By AMY E. MACK. 132 pages. 39 illustrations. 7½-in.×6-in.
(The Australian Book Co. Price 3/6 net.)

This little book consists of a number of short articles dealing with the plants and animals of the bush which in the neighbourhood of Sydney is rapidly giving way before bricks and mortar, trams and trains. The pictures and the descriptions deal, therefore, with matters on the other side of the world, and cannot fail to attract and interest nature lovers in the old country.

Dictionary of Photography.—By E. J. WALL, F.R.P.S. 738 pages. 7½-in.×5-in.
(Hazell, Watson & Viney. Price 7/6 net.)

A hundred new pages have been added to this the ninth edition of a most useful work, which is full of information, suggestions and valuable hints.

The Oil and Bromoil Processes.—By F. J. MORTIMER and S. L. COULTHURST. 99 pages. 8 illustrations. 7-in.×5-in.
(Hazell, Watson & Viney. Price 1/- net.)

The success which has attended Messrs. Mortimer and Coulthurst's handbook is evidenced by the production of this second and revised edition.

The Doctor and the People.—By H. DE CARLE WOODCOCK. 312 pages. 7¾-in.×5-in.
(Methuen & Co. Price 6/- net.)

The appearance of this book is most appropriate. It brings before one the everyday life of the doctor, and many points which the ordinary member of the community will do well to study, while it is claimed that it exposes faults of raw legislation which is the work of men who, though mature politicians, are nevertheless ignorant of sociology.

Zoölogy.—By GRAHAM KERR, F.R.S., F.Z.S. 99 pages. 13 illustrations. 6½-in.×4½-in.
(J. M. Dent & Sons. Price 1/- net.)

A small primer when it gets into the hands of a young person who is interested, very often produces results of which the writer may well be proud. This little book seems intended, however, rather to give a very brief outline of the animal kingdom and the method of evolution for the adult enquirer.

For and Against Experiments on Animals.—By STEPHEN PAGET. With an introduction by Lord Cromer. 344 pages. 16 illustrations. 7½-in.×5-in.
(H. K. Lewis. Price 3/6 net.)

We are glad to see that the word vivisection does not appear in the title of this book, and though there are some who, when they have once become biased against a matter, are not easily persuaded to look upon both sides of it, we would urge all those who pride themselves on being anti-vivisectionists to read Mr. Paget's book and Lord Cromer's introduction to it.

NOTICES.

A REGULATOR FOR X-RAY TUBES. — In *The Archives of the Roentgen Ray* for May, 1912, Dr. Gustav Losse describes the air regulator for X-Ray bulbs which has been perfected by Bauer. By its means a measured quantity of air may be allowed to enter the bulb. The advantages of the invention are illustrated by Dr. Losse from his every-day practice. Occasionally in damp or stormy weather he gets a certain amount of reverse current from his coil which is very deleterious to the life of the tube. The cure is a valve tube which soon, however, becomes so hard that it has to be regulated. To obviate the continuous annoyance of softening this, Dr. Losse has preferred to put up with a reverse current. The attachment, however, of a Bauer regulator has given him a perfectly useful and practical instrument. The secret of the production of a fine skiagram lies entirely in the choice of rays of the appropriate degree of hardness. By adjusting the hardness by means of Bauer's regulator we can obtain plate after plate perfectly similar in appearance and exposure. It is no longer a fault for an X-ray bulb to become rapidly hard because this difficulty can now be easily overcome while the reverse cannot. In the future, perhaps, the manufacturer will advertise his X-Ray tubes as the best on the market, because they become rapidly hard.

BOOKS ON VOYAGES AND TRAVELS. — Messrs. J. Wheldon & Company's catalogue issued under this title includes a number of books on Australia and New Zealand, and indeed many other countries abroad.

THE VEGETATIVE CHILD.—English doctors have pointed out before now that the puny boy is the outcome of too little clothing. Dr. Mary Sutton (of New York University) contributes to *The Child* for May "a Biologic Study of Early Child Life," and touches on the fact that during the vegetative period of life the child has a relatively large radiating surface to the body, and despite the more rapid formation of much more heat in the child than in the older individual, the vegetative infant has little power of resistance and therein lies the danger of improper or inadequate clothing.

THE REMOVAL OF TESTS FROM FOSSILS.—In *The Naturalist* for May, Mr. Buckman gives the following directions for removing the tests from fossils (especially of brachiopods of which natural casts are rarely met with). Choose specimens which are not crystalline, and preferably those which are likely to have a close grained hard internal core. Heat them to redness (in a fire or preferably by means of a Bunsen flame, spirit or blow-lamp) and drop them into water. Much of the test will then fall off and the rest can be detached by brushing or the delicate use of a pen-knife.

ASSORTATIVE MATING IN MAN. — The statistical facts brought forward by Dr. J. Arthur Harris in the May number of *The Popular Science Monthly* make it highly probable that a great variety of physical and mental characters influence human mating, and show that, on the average, similar individuals tend to marry. Dr. Harris thinks that his results will be received with much scepticism as the "charm of the disparity" and "the selection of opposites" has been so long asserted that the notion will not readily be given up. He thinks that this scepticism may be ignored, but reminds his readers that popular beliefs often contain a scrap of truth.

BIBLIOTHECA CHEMICO-MATHEMATICA. — The latest number of Messrs. Henry Sotheran & Company's scientific catalogue contains the titles of upwards of two thousand books dealing with Mathematics, Astronomy, and kindred subjects, arranged under the authors' names from the letter "E" to "I." Those of our many readers who are interested in these subjects should make a point of getting a copy.

A HANDBOOK OF MARINE AQUARIA.—The notes which have been issued on the Aquaria in the Horniman Museum, Forest Hill, have been entirely re-written. The creatures dealt with are those which are generally to be found in the Aquaria there. Rare forms are not included, as in their case special labels are attached to the tanks when they happen to be on view. This little handbook cannot fail to be of great use to all students using the museum, and it costs but a penny.